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ENGINEERING & MINING JOURNAL-PRESS

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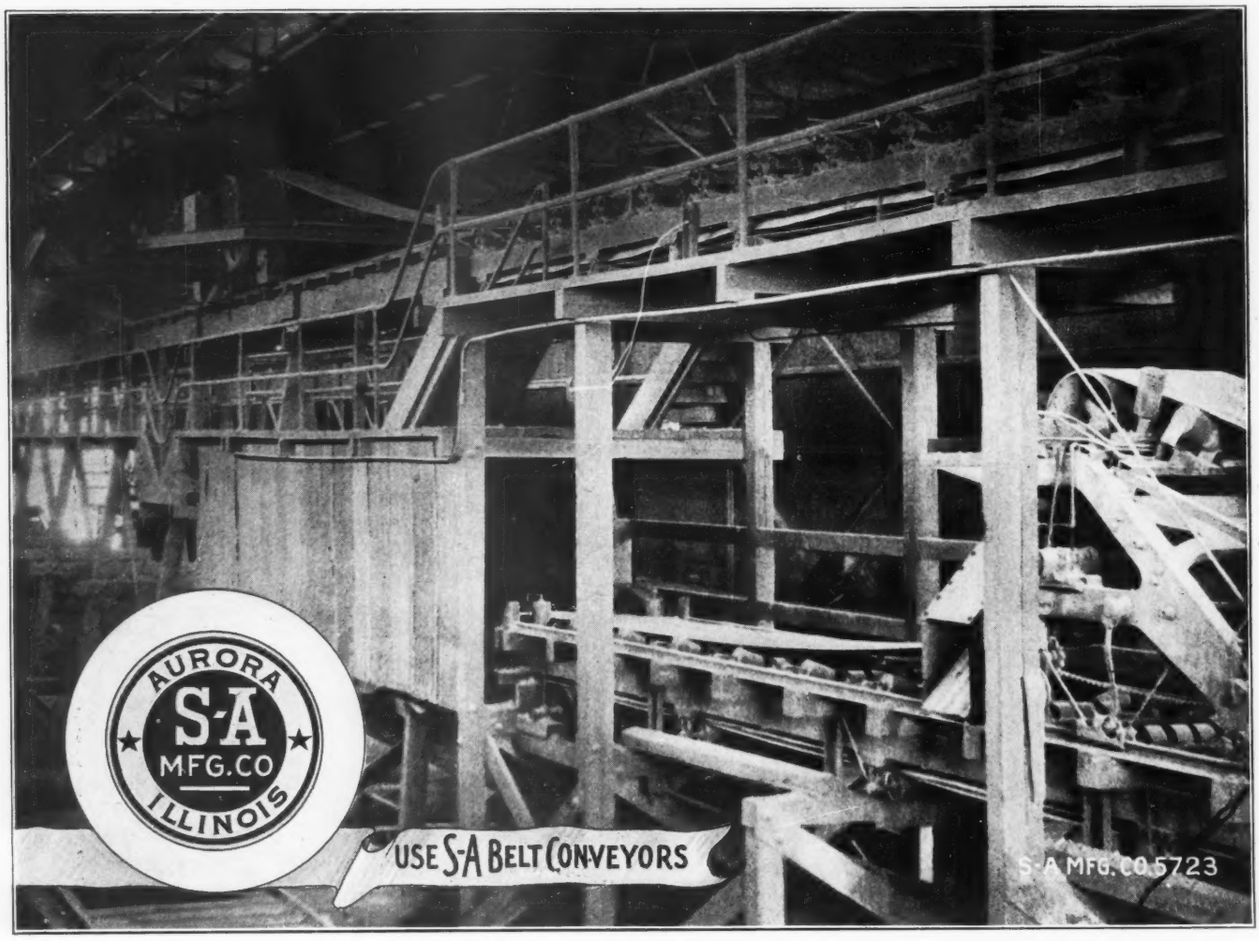
A WEEKLY JOURNAL REPRESENTING THE WORLD'S MINING AND METAL INDUSTRIES

January 6, 1923



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JOSIAH EDWARD SPURR, Editor

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The Petroleum Reserves of the United States

THAT there are unmistakable signs of an increasing petroleum shortage in the United States, and that American petroleum reserves, if used at the present rate of consumption, would be exhausted in a matter of a few decades, has been currently inferred by geologists from a study of the production and the consumption curves, and from a consideration of the available field within the United States and the short-lived nature of the great fields which have been successively opened up. Among those who pointed out these things, and drew the inference of an imminent falling off of production as compared with consumption, was, prominently, Mr. David White, till recently Chief Geologist of the U. S. Geological Survey.

But the oil geologists do not agree. Mr. A. C. Veatch, one of the best known and most experienced oil geologists, the chief geologist for the Sinclair company, in a recent address before the Petroleum Institute at St. Louis, denies the likelihood of approaching exhaustion, taking the ground that the probability of new discoveries of oil is indefinite but almost limitless. He points out that the range of geologic structures recognized by geologists as favorable for oil accumulation has been steadily enlarged. Yet in some parts of Mr. Veatch's address one may read the possibility of an approaching diminution of supply, which he decries: "It is only in the United States that the sedimentary rocks have been intensively developed for oil, and great as the development has been here, the oil in the sedimentary rocks of the United States is by no means exhausted." And, "Unless foreign fields are developed more thoroughly, the time must inevitably come when all nations will be seriously handicapped." We are inclined to grasp Mr. Veatch's conception of vast petroleum resources remaining in the outside world more clearly than his belief that the approaching exhaustion of the petroleum in the United States is a "bogey." It is highly desirable, however, that a committee or commission of competent petroleum geologists make a joint report on the petroleum reserves of the United States, formulating concisely those conclusions on which they find themselves able to agree. This is a definite task to which the petroleum committees of the American Institute of Mining and Metallurgical Engineers and the Mining and Metallurgical Society of America might well address themselves, in co-operation.

The Rodrian Electro-Metallurgical Process

AMONG other constructive suggestions that we might make in wishing our readers a prosperous new year, we advise that they put no money in the latest metallurgical wonder of the world, the Rodrian Electro-Metallurgical Process. We first heard of this last July, when a subscriber asked for advice. At that time we visited the New York office and plant of the Rodrian Electro-Metallurgical Co. at 410-416 East 32d St., but were unable to learn any of the details of the proposed process. However, we were to be given information for an article in two or three weeks.

Next, we ran across a patent granted to this company, No. 1,426,507, mentioned in our Dec. 9 issue, which did not seem to us of particular moment. Then came a half-page advertisement in the New York *Morning Telegraph*, with an accompanying editorial write-up. This was for the purpose of selling stock "to investors who seek an exceptional opportunity for an investment." The advertisement goes on to say that "we have our own mining properties with an inexhaustible supply of ores from which we have established an average recovery of over $1,000 per ton, through our process. We recover from any sulphide ore 10 to 25 times more precious metals than any other known process will recover." This encouraged us to send for a prospectus, as per invitation, so in an early mail came "Prospectus No. 2," an attractively printed and illustrated booklet containing the following surprising observations, among others:

> "It has been our experience to make complete recovery of all metals contained in any given ore.
>
> "Our new metallurgical theory upon which our process has been perfected and patented has practically proven that not only do we make a total recovery of all metals which are recovered by other known methods, but we also recover the metals which other methods do not recover, such as the metals from oxides, sulphides, metal salts and colloidal metals which are found compounded and fused with other elements, such as silicia, calcium, magnesia, sulphur, etc.; hence our remarkable high recoveries and the reason why we do obtain higher results at our factory than those reported by the assayers on the same ore.
>
> "We may state here that we are the pioneers ushering in a new era for the mining industry that our new theory has proven correct under the 'acid test' and that our corporation is heading for the greatest surprise as a money maker in all modern enterprises."

The company has a secret laboratory at the New York address mentioned, and claims to have purchased the Gold Hill mine, in North Carolina, and to have options on the Barringer and Isenhour mines and the Whitney property in the same district. The special electric equipment at the laboratory "has a capacity of 850 amperes by 220 volts"—board measure we presume. The mill at the property has a few "Wilfrey" tables. Among other advantages of the Gold Hill property "there are quite a few families living nearby, making it a pleasant place to approach and eradicating the atmosphere of wilderness" that curses so many of our mining camps. Being situated in the South, it can be operated throughout the year, "and not, as is the case in the most northern mines, when practically all operations are at a standstill, during the winter months."

The following, from the prospectus of the Rodrian company, will appeal to geologists:

> "Why do we recover more than the assayers report in any given ore? Our contention is, that from the fluid to the solid state of the earth all elements specially all metals

have been burned, oxidized, dissolved and precipitated numberless times, compounded and fused, so that they are not recognized as metals. Our process condenses the metal forming substances found in these compounds into metals and recovers them. Hence our high recoveries and the proof of our contention."

The company also has other things up its sleeve, including a "Radio-Electrolytic" cure for rheumatism, sciatica, and neuritis; an electro-active fertilizer; and a new electric storage battery. There is some choice humorous matter in the prospectus about the fertilizer, and as to the battery "the advantage and novelty in our battery is the preparation of the active mass, and the Formation Process." Unfortunately, we have not the space to repeat more of this buncombe, but interested readers can no doubt be accommodated by dropping the company a postcard.

Before writing this we made a second call at the office of this outfit to see about the promised article. Mr. Henry Brownstone is president; Richard Rodrian, apparently the inventor, is vice-president; and other officials and directors include Messrs. Suss, A. Graf, Pugatsky, Richter, Stamm (August and Hedwig), Haas, Speth, E. Graf, Krone, Nordstrom, Kuehn, and Baier. Apparently they are all Germans, and not gifted with much mining or metallurgical intelligence. The list does not include the "mining expert" to whom we were introduced, a Mr. J. L. Mittenbuhler, who claims to be well known in the West and to have been a near-producer of manganese in Tennessee during the World War. Upon our entry in the office we were told, after our card had been passed about the room—"Oh yes, you are from the Hill-McGraw Co., aren't you. That reminds me, we will have to pay up our subscription." We assured the officials that our call was not inspired by any sordid desire for money, handy as that is at this time of the year, but that our visit was to find out something of the metallurgical details of their wonderful discovery. However, we were not allowed to stick our head inside of the laboratory and the process is still a great secret—the promised article is still to be deferred "from thirty to sixty days while we finish some important work"—doubtless rounding up the suckers.

A $5,000,000 plant is to be built at Gold Hill, where the ore to be treated has been found, according to Mr. Mittenbuhler, to run from 10 to 40 oz. of platinum to the ton. It is "collodal" and "complexed." Next year, according to our "expert," metallurgists will throng to the proposed $5,000,000 North Carolina plant in such numbers that they will have to be handled the same way as visitors to the stockyards in Chicago. Well, the *Engineering and Mining Journal-Press* will be the first to tell all about it.

"Un-Amalgamating" Bendigo

SHEER NOVELTY, in these days of combining and merging and consolidating big companies to make bigger ones, draws attention to the recent partitioning of the Bendigo Amalgamated Goldfields, Ltd., of Australia, into six smaller companies. Bendigo boasts of a golden past no less romantic than that of Cripple Creek and Goldfield, but future prospects are not bright. Some years ago practically all of the once-famous mines in the district were consolidated to form the Bendigo Amalgamated. The company prospected systematically, but little of importance was revealed.

A recent dispatch describes the latest move. "Now it is felt that greater public interest will be manifested in consequence of the formation of six separate companies operating six areas into which the property has been divided, and the shareholders have approved this arrangement. . . . The Bendigo Amalgamated has entered into an agreement with each of the new companies for managerial service."

Each Bendigo shareholder is to become *pro rata* a shareholder in the little Bendigos; the management, and presumably the method of operations, are to remain as they are. A little more complicated bookkeeping will be about the only difference. Why the change? Merely to stimulate "public interest," which, whether it be in regard to millinery, movies, or mines, means to separate from their money the long-suffering individuals who constitute that "public." An uncharitable and imaginative person might suspect a plan to boost Un-Amalgamated Bendigo No. 1, while the five other little brothers go hungry. The esteemed public is supposed to buy U-A. B. No 1 while the insiders get out. Then attention would be turned, let us say, to U-A. B. No. 5, and it would wax fat at the expense of the others. Up would go the price of No. 5 shares and out would go the solicitous gentlemen who desire that the "public manifest interest." If there were no hitches the others would follow in sequence.

How to Find a Mine

THE PREMIER MINE, in the Salmon River district of British Columbia, is exciting comment over the generous dividends it has put into the pockets of its delighted stockholders. Nevertheless, it must not be overlooked that several companies took a fling at the Premier when it was a prospect and retired with severely burnt fingers and hands before the fortunate present owners discovered the rich oreshoots that have since supplied the dividends.

The success of the Premier has been a standing challenge to the prospectors and mining men of the Salmon River district. The surrounding country, in spite of its thick cover of hemlock and moss, has been combed from river and glacier to skyline. Many have had a hunch that another center of intensive mineralization might be found in the near neighborhood of the Premier. Others have interested themselves farther away. Of the many prospects, the Big Missouri is considered, by knowing prospectors, to have the makings of a mine. Anent the Big Missouri, the following story was told to us, and though it may lack absolute accuracy in some details it is worth relating:

An excellent ore showing was discovered upon the Big Missouri claim, which lies north of the Premier an air-line distance of about four miles, and not far from the Salmon River glacier. A hole was sunk upon the showing, and at a moderate depth the ore gave out. At the place in the prospect opening the orebody was apparently cut off by a slip which entered one side of the shaft. Despite this fact, the claim was bonded several times to different parties. Engineers and geologists made examinations and reports. Mining men went shrewdly over the ground. Diamond drilling was resorted to in an endeavor to pick up the continuation of the ore or to find more ore. Failure attended all these efforts, and the opinion was current in the region that the Big Missouri had good ore showings but (and this was usually told in a subdued voice) "the ore did not go down." This view was not only passed around

by the casual wayfarer, but astute engineers voiced the same opinion. The option was hawked around, and we are told was finally taken up by R. B. Trites and R. W. Wood, two of the three men who had the courage to back R. K. Neill when he took hold of the Premier. Recently, Trites and Wood sent Harry Howison up to the Big Missouri to find the ore. Howison determined to start work in the prospect hole. Near by was a small pond which seeped into the shaft. A ditch was started near the working for the purpose of draining off the water. In digging the ditch, the orebody was picked up. It had always been there, and had been overlooked for the want of a pick driven into the ground. Rich shipping ore, we are told, was found. According to our informant, the diamond drilling, on the assumption that the deposit dipped in a particular direction which was the opposite to the fact, has been done in the footwall of the vein. One hole picked up the ore on the hanging-wall side, but the showing was not deemed to be of sufficient importance to sink a shaft at the time. It is a good story and we hope that the subsequent development will prove an orebody of considerable size in the Big Missouri.

We have related this story mainly because it parallels to a certain extent the story of the Premier but more to encourage the mining man to make several inspections of his ground from as many angles as possible before giving up his option on a claim which instinctively appeals to his mining sense. In both of these cases success followed repeated failure. A succession of attempts was apparently necessary. In our opinion, persistent experimentation from an unprejudiced point of view would have won success in the first instance. We also believe that it is necessary in any district to have a pyramid of failures in order to find a mine.

The Market for Experience

MANY MIDDLE-AGED MINING ENGINEERS will gather crumbs of comfort from a recent utterance of one of the richest men in the United States, who maintains that poverty at forty is no evidence of failure if experience has been gained. Affluence, it is averred, or even the accumulation of a competence, before the half-century mark is reached, is likely to lead to a sense of security in regard to the future, which may inhibit the striving for achievement that should mark the efforts of all civilized beings, especially engineers.

The drawback to experience as an asset, however, is the inability of the owner to "cash in"—to exchange his wares for an amount representing even a modest interest on capital expended and pleasures foregone. A rolling stone gathers no moss. It may acquire a polish, however; but this adds nothing to its value as a constituent of concrete. Experience, likewise, may be valuable, but it cannot be appraised in the open market. In fact, a lack of a certain type of experience may prove the best recommendation. An example of this occurred recently: A call was made by an industrial firm for an engineer to recommend changes in its plant, whereby economies might be effected and efficiency promoted. An early applicant was asked what experience he had in that particular work. He replied, "None at all," explaining that therefore he would be able to study the problem from an entirely new angle, being unbiased by anything that had been done or considered before. He got the job and made good; but his lack of experience in that particular branch of industry was more than counterbalanced by an ability to think, plan, and execute on broad-gage lines and according to common-sense principles. An acquired talent to reason simply and directly is an asset that no engineer can afford to ignore; and, if he has reached twoscore years without having accumulated anything more tangible, he is at least well equipped to enter the race in that stage of life's journey at which his faculties are in their prime.

Experience that can be turned to account does not necessarily mean the acquisition of facts and figures; but, rather, an ability to eliminate the non-essential. It does not mean proficiency in one circumscribed art or industry, although it may include this, and more. If experience does not teach us to do all things well, we have failed to learn its lesson. The Great War brought this fact home to many individuals whose motto insists that the shoemaker should stick to his last. It was not the knowledge of mining engineering that enabled Herbert Hoover to help—swiftly and efficiently—the thousands of stranded Americans in Europe late in 1914, thereby relieving our embassy in London in a situation that had overtaxed the ingenuity of the government's representatives. He did not make a success of the task because he was proficient in handling refugees. He just happened to be a man of experience—and a mining engineer. It was not proficiency in architecture or building construction that enabled Colonel Peter N. Nissen to evolve a simple and serviceable hut for the use of the troops on the Western front, thereby solving a problem that probably would have baffled a committee of the most proficient house designers and building constructors in the world. No, he did not make a success of hut design because he was proficient in that art. He just happened to be a man of experience—and a metallurgist—whose ingenuity had found outlet at one stage in his professional career in the invention of the high-duty single-mortar stamp mill that bears his name.

Art is long; life is short. If there is one thing that an experienced mining engineer should learn, it is that a good shoemaker, in the event of emergency or necessity, will probably prove a capable workman for the laying of linoleum. In other words, this world of ours offers extraordinary scope for the man of experience. The engineer who has learnt the value of keen tools and the need for ample power behind the heavy machine; who appreciates instinctively the strength of support needed to stand stress and strain; who favors the neat and effective scheme for the solving of a technical problem, the direct method for the removal of obstacles; who has learnt the value of sincerity in the compilation of reports, and the need for tact and diplomacy in his dealings with the laborer in the mine, as well as with the director in the home office—such a man will find that he has all the fundamental qualifications for—a writer of technical articles, shall we say? All that is required is practice with the tools.

Similarly, in other branches of endeavor, the mining engineer has great opportunities, which if exploited fully should bring kudos to himself and credit to the profession. Too often, however, he stays in the same groove, unaware of his own manifold abilities. If correspondence schools had a course in self-confidence—aggressiveness even—many capable mining engineers could learn much to their material advantage, thereby profiting by that experience which, in early life at least, is the most costly form of education.

The Argonaut Investigation

By T. A. Rickard

THE Argonaut disaster, involving the loss of 47 lives, has attracted so much earnest attention among members of the mining profession that I do not apologize for making note of the report of the Governor's committee. My readers will recall the fact that Governor Stevens of California appointed a committee to investigate the matter. This committee consisted of Messrs. A. B. C. Dohrmann, W. J. Loring, and J. C. Williams. Mr. Loring represented the mine operators, Mr. Williams the working miners, and the chairman, Mr. Dohrmann, an astute and highly respected merchant of San Francisco, represented the public. The report, a summary of which appeared in the *Journal-Press* of December 23, was given to the press on December 7; it is not a white-washing document; on the contrary, it lays blame where it belongs and makes suggestions that ought to prove valuable for the promotion of safety in mines. The shift-boss that first detected the fire is blamed for failing promptly to notify the miners underground and for not sending the skip to them as soon as he discovered the fire; he is blamed for failing to stop the fan. The prompt stopping of the fan, says the committee, would have reversed the current of air through the mine and thereby saved the men in the bottom workings. On the other hand, the stopping of the fan after the first hour of the fire would have been useless, the committee believes. The effort to extinguish the fire, with means wholly inadequate, was a mistake of judgment, because it disregarded the consequences, namely, that unless the fire was extinguished promptly the men in the mine would be asphyxiated, provided the ventilation continued unchanged. However, the shift-boss cannot be severely reprimanded, considering the fact that he had received very little, if any, training or instruction as to what to do in case of fire.

This passes a part of the blame—fairly, it seems to me—to the management of the mine. The findings of the committee are so remarkably in accord with my own conclusions, as expressed in the series of articles published in these columns, that they call for little further comment, except to say that I believe that any committee of experienced mining engineers, informed of the facts, would concur. As to the origin of the fire, the committee was unable to decide, but of the three possibilities considered, the most acceptable are stated to be incendiarism and defective electric wiring. The third possible cause, which was discussed in the testimony before the committee, was carelessness with cigars or cigarette stubs, carbide lamps, or candles. As to this, it is fair to say that the committee was not in a position to arrive at a definite opinion; the testimony was entirely insufficient, because no adequate investigation was made by those—not the committee—upon whom the duty devolved. Obviously, incendiarism offers a ready alibi for the Manager and the Safety Engineer, and on that account it was accepted as an adequate explanation by the officials of the mining company and by those of the Industrial Accident Commission. Evidence has come to me recently indicating that a short-circuit was the cause. The timbers at the place of the fire, at the 3000-ft. level, were seen by a competent witness to be scorched only an hour before the disaster started. The phrase "bright fire", as used by the shift-boss to describe what he saw, suggests the appearance of the kind of fire caused by short-circuiting. It is probable that an electric wire became displaced and pendant so as to stretch and break the insulation. The so-called circuit-breakers are not sure preventives of such accidents.

It is the opinion of the committee that the rules and regulations in existence relative to the operation of metal mines are adequate. The report states that it is only necessary "to see that those already in force are carried into effect". To this I demur, for since the disaster last August the managers of mines in California have done a great deal more than is prescribed by the regulations to safeguard the lives and properties in their charge against the hazard of fire; they have done this of their own accord, it is true, but it appears to indicate that a few reasonable regulations would be welcomed by them; moreover, this report of the Governor's Committee reproduces the recent report of the Committee on Fire Hazards and endorses it; thereby admitting that further reasonable regulations are desirable. On the other hand, the committee says nothing in regard to any blame falling on the engineers of the Accident Commission, whose business it has been to inspect mines and to give directions for the safety of those working in them. The fact that the Argonaut was inspected as lately as April 9 of this year by the mining engineer of the Commission and the further fact that the same mine had been the victim of a fire only three years ago suggests strongly the incompetence of those upon whom, under the State law, falls the responsibility for attending to such matters. Moreover, the report of the Committee ignores the failure to connect the bottom workings of the Argonaut with those of the Kennedy; it was a grave error, I insist, not to connect these two deep mines in such a way as to furnish an exit from either one of them through the other in the event of a great emergency, such as that of August 27. This lesson of the disaster must not be overlooked. Since then a sincere effort has been made by the mine managers to co-operate with the Industrial Accident Commission in formulating such regulations as may be necessary to prevent loss of life from fires underground, but the excellent spirit shown by the mine managers has not been reciprocated by the officials of the Commission, with the result that ill feeling has been engendered. Before long the matter will come within the cognizance of the State Legislature, and I hope that the gentlemen assembling at Sacramento will take proper note of the fact that the responsibility for the Argonaut disaster should be shared between the management of the mine and the officials of the Commission. When all is said and done, the disaster could have been obviated if the Safety Engineer of the Commission had performed his duty properly, for in that event, warned by the fire of 1919, he would have insisted upon the two mines being so connected that the main shaft of each could be used as an exit in the event of another fire in the deep workings of either mine. To provide this means of escape was within the authority of the Safety Engineer; it was a safeguard that was worth a dozen regulations.

Mining by Briggs Underhand Square Setting

Method Used by Calumet & Arizona Company for Working Broken Masses of Sulphide Ore Capped by Barren Sandy Pyrite or Brecciated Silica

By Robert H. Dickson
Chief Engineer, Calumet & Arizona Mining Co.

SQUARE SETTING has been one of the common methods used in mining the ores of the Warren district, Arizona. At present it is used to a limited extent in places where it is especially adapted, as in soft or friable ores that will not stand without timber; and also on pillars between sections mined by other methods where ground is heavy. As generally understood, square setting is overhand mining, starting on a level or on the bottom of an orebody and carrying the stope upward. Most of the square setting in the Calumet & Arizona mines is underhand mining, beginning at the top of an orebody and working small sections of the orebody downward.

Portions of the larger sulphide lenses of the Briggs and Junction mines of the Calumet & Arizona company consist of a broken mass of copper and iron sulphides, overlain by an irregular tabular mass of sandy pyrite, carrying no values, or by a brecciated mass of silica. In case the back of the orebody is sandy pyrite, one of the most important considerations is to keep the sandy back from sloughing into the stope opening, thus lowering the grade and at the same time seriously threatening the stability and security of the stope. In mining these orebodies by overhand square setting, only very small sections could be worked, and even with these there was always a possibility of having trouble holding the stope as the back of the orebody was approached. After considerable experimenting in attempting to mine this class of orebody by a more satisfactory method than overhand square setting, the Briggs underhand square set method was evolved. Overhand square setting is not new, but the sequence of operations, and manner of hanging the sets in the Briggs underhand square setting method may prove of interest.

As adapted by Fred Juliff, foreman of the Briggs mine, this method consists in blocking out the orebody by crosscuts and raises into stope sections of suitable size; then mining the sections around a central raise in regular sequence, starting at the back of the stope and working downward; then gobbing each section as soon as it has been cleaned out. The size of the sections varies from 10 x 20 ft. to 25 x 35 ft. horizontally, and extends vertically from the level or bottom of the ore to the back or level above. Square-set timbers used are 10 x 10 in. in dimensions and are of Oregon pine. Sets are 5 ft. x 5 ft. x 7ft. 10 in. high. Split lagging is used for gob fences and 2 x 12-in. plank for flooring and lagging overhead.

Fig. 1 shows a plan of the stope about to be described. There are four sections about the central raise—namely, sections *A*, *B*, *C* and *D*. Section *B* has already been worked out and gobbed; section *D* is being worked; and sections *A* and *C* will be mined in course of time. In this orebody the back of fine pyrite is nearly horizontal and about 50 ft. above the level. The two-compartment raise (manway and chute) is run up to the back in blocking out the ore. This raise is continued to the level above to facilitate handling supplies in the stope, and also as a means of introducing fill or gob into the sections. Raise timbers are regular square-set timbers, but frequently it becomes necessary to make use of 3-in. plank cribbing in going through sand pyrite or brecciated silica.

Stoping in section *D* (Fig. 3) is started on the top floor by taking enough ground out from the one side of the raise, as the east side, to make room for the set of timber and catch up the back. Sometimes enough ground can be taken out to make room for a whole set, but often spiling must be used to catch the back. Spiling 4 x 6 in. x 8 ft. long can easily be driven with a double

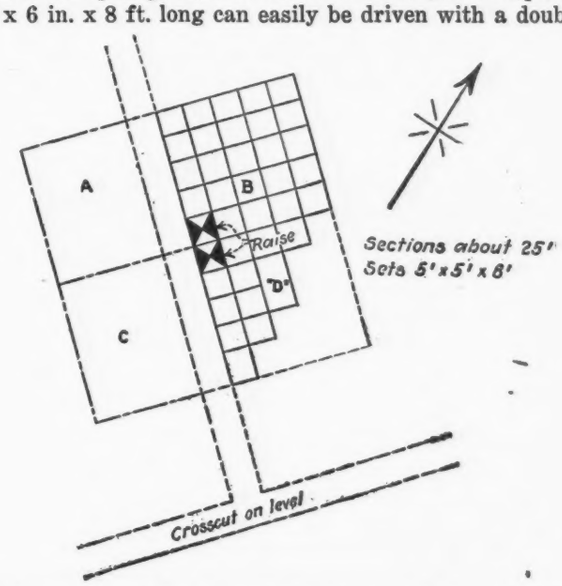


Fig. 1—Map of fifth floor of underhand square-set stope, Briggs mine, showing section lines and sill floor below

jack while the soft material at the toe of the spile is being picked out with a bar. Lagging can often be slipped in over temporary stulls in order to catch up the back.

When the back is caught up, ground is taken out (if not already out), to make room for sills. Sills for the set are laid, posts are stood, and caps and ties are blocked in position. The entire set is securely blocked to back. With this set blocked, the set to the south of the raise is put in, in like manner. Then the set between the two is mined out, using similar precautions in catching up the back. The back must always be carefully lagged to keep the pyrite from running.

As mining has been carried out a distance of about 5 to 10 ft. in a quarter circle about the raise or chute, stoping is started on the floor below (or the fourth floor). The top floor sets are holding the pyrite, so it is only necessary to support these sets while the ground is being taken out below. Several methods are used in supporting the overhead timbers. Under all conditions,

one-half of the weight of the overhead set timbers is borne on the raise or adjoining timbers, so it is only necessary to provide for hanging the opposite half.

One method of supporting timbers is by the use of a cantilever beam 10 ft. long, supported at the center by an iron clevis or strap that fits around the cap or tie above, as shown in Fig. 3. The free end of this 10 x 10-in. beam supports the set. This is not often employed, as there is a tendency for the beam to snap in two, under little shock.

Another method is to hold the timbers in place by nailing 2 x 10-in. lagging as supporting brackets. This is never used except in cases where there is only a slight weight to be supported.

The usual method of hanging the timbers is shown in Fig. 2. Two 4 x 6-in. stulls are thrown from the solid cap, or tie, to the diagonally opposite one. As the cap at the top of the stull is held rigid horizontally, these stulls take care of any downward thrust. Two 2 x 10-in. lagging are nailed from the top of the posts in the solid to the bottom of the tie, or cap, as shown in Fig. 2, which act as tension members supporting the sills. A third 2 x 10-in. lagging ties the cap in front to the cap supported by the stulls. With timbers supported, the ground is removed below, sills are laid, and posts placed in position. Then the set is blocked from below. Stulls

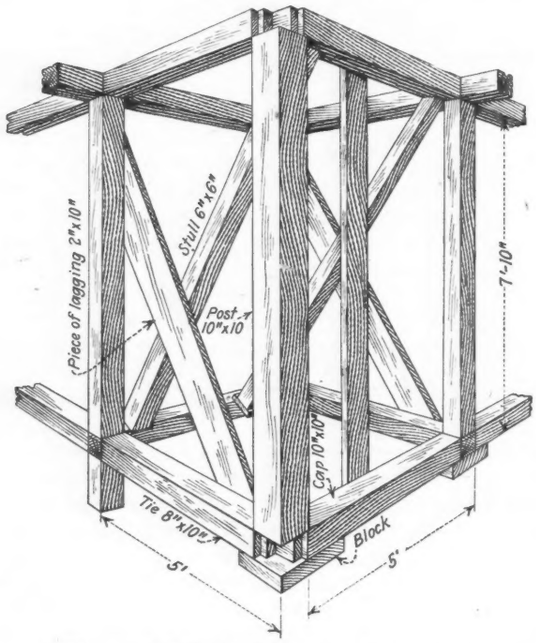


Fig. 2—Method of hanging square sets

and hangers are taken off and used on the next adjoining set.

Stoping progresses on the top floor (fifth), which is being worked under pyrite, and on the floor below (fourth), where the sets of the fifth floor are being supported while ground below is worked out and then timbered, the top floor always being at least 5 ft. in advance of the one below. As the fourth floor progresses 5 to 10 ft. in a quarter circle from the raise or chute, stoping starts at the raise on the third floor. The stope is thus worked in the shape of a funnel, so as to allow all broken ore to run into the chute without having to muck it.

In the stope as described, work would usually not be carried on in more than two places in the section at the same time. Great care is taken to keep the timbers securely blocked to the back.

The top floor is the first to be worked out, and the bottom (first) floor the last. By the time the first floor is being cleaned up some of the ore is at a considerable distance from the chute. If possible, extra chutes are punched up from the sill to take care of this ore and

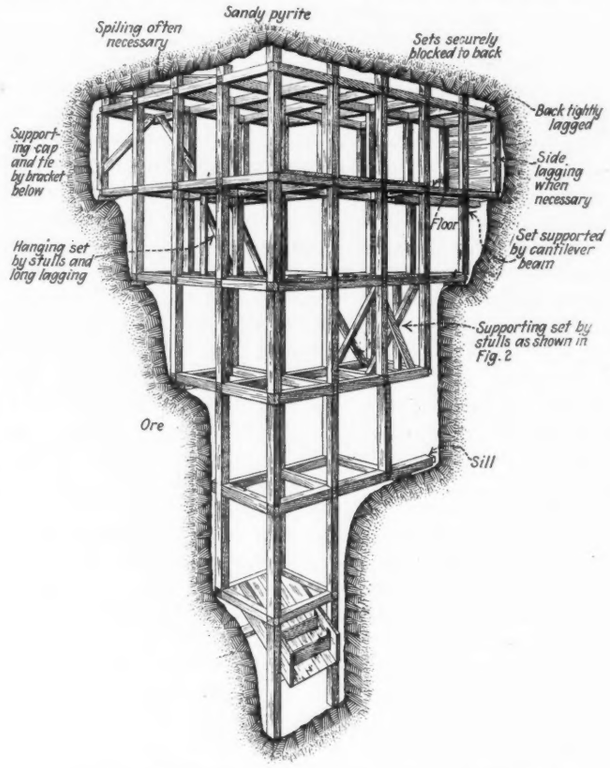

Sandy pyrite
Spiling often necessary
Sets securely blocked to back
Back tightly lagged
Supporting cap and tie by bracket below
Side lagging when necessary
Floor
Set supported by cantilever beam
Hanging set by stulls and long lagging
Supporting set by stulls as shown in Fig. 2
Ore
Sill

Fig. 3—Perspective of section "D," looking east

obviate mucking. On one side of section *D* the timbers will fit against timbers of old section *A*.

In most of the stopes of this character, very little powder is needed, practically all of the ore being picked out. As the stopes are worked, with the bottom at about 45 deg. sloping to the chute, it is only necessary to touch the ore to make it run. Occasionally hard ribs of silica are encountered, when a few holes with a plugger machine and a small amount of powder will break the material. As nearly all shooting is done from underneath, there is practically no chance of breaking the hanging timbers shown in Fig. 2. Several floors are kept above the miners. Sections are wet down from time to time to keep down the dust. Sides are usually lagged. Two men work in a section at a time and usually average two sets per shift, except when catching up the back.

When a section has been worked and cleaned out, it is lagged at the side and gob is introduced from the level above. Gob or fill is obtained from development or prospect work in lime. When the section has been completely gobbed, work is then started on the adjoining section.

As this method has been worked, it has been found to be very safe and much cheaper than any method before tried on this character of ore. Teamwork and a thorough knowledge of the details on the part of the miners have been in large measure responsible for its success.

The Story of the New Cornelia

BY T. A. RICKARD

THE New Cornelia Copper Company, which owns the important group of mines at Ajo, in Arizona, is one of the principal copper enterprises of the world; its operations have been the subject of a series of interesting articles by our Mr. A. W. Allen; therefore an outline of its early history will be timely. My information concerning the beginnings of this venture is derived from several sources, including a pamphlet published three years ago by Mr. John R. Boddie, formerly secretary of the two companies that preceded the one that is now exploiting the copper deposits of Ajo.

The first mining done in this locality was in 1854 by a company of prospectors organized at Los Angeles by Major B. Allen, J. D. Wilson, William Blanding, and others. This party consisted of 20 men; they went first to Yuma, where they divided, some of them going southward into Mexico while the remainder took the trail to Tinaja Alta, where they heard of the copper deposits of Ajo, which is 90 miles east-southeast from Yuma. They found attractive outcrops of copper ore and set to work energetically, but their operations were subject to many annoyances and difficulties, because that part of Arizona was still controlled by the Mexicans, despite the Gadsden Purchase, for the new international line had not yet been fixed by survey. The Mexicans tried to drive them away, but they held on. The first shipment of ore came from what is now the western end of the New Cornelia workings; it was hauled in ox-carts to San Diego, four hundred miles across the desert. Later shipments were hauled to Yuma and floated on barges down the Colorado river to the head of the Gulf of California where they were loaded on shipboard for Swansea, in Wales, as related by Courtenay de Kalb, in the 'Mining and Scientific Press' of January 26, 1918. For forty years a desultory effort was made to exploit the copper deposits of Ajo, on a small scale and precariously. Then came a new chapter in the story.

This later story begins with a man named A. J. Shotwell, who, in 1896, persuaded A. W. Hopper, an iron manufacturer living at St. Louis, to interest himself in a lease and option that Shotwell had secured on a prospect in Arizona. Hopper went to Ajo and subsequently organized the St. Louis Copper Company, which erected a two-stamp mill at the mine and therewith demonstrated not only that the copper ore could be concentrated, but that it also contained some gold and silver. Thereupon a 10-stamp mill was built. The property that had been leased by the company consisted of only one full claim, the Cardinoff, but Shotwell had a three-years lease on five adjoining claims, named the Ajo View, Escondido, Golden Eagle, D. B. Hill, and Valley. The owners of these were the original locators, Childs and Jacobs. The option price on the group of six claims was $200,000. Shotwell hoped by leasing the one claim to the St. Louis company to obtain enough money for the purchase of the other five. Unfortunately his scheme miscarried, for the 10-stamp mill was not operated at a profit, the two reasons therefor being bad management and insufficient water. Apparently there was nothing wrong with the ore. The company, after spending $45,000 for a gross revenue of $35,000, gave up the ghost. Whereupon Shotwell, in no wise discouraged, organized a new company, named the Rescue Copper Company. It was intended to retrieve the losses incurred by its predecessor.

At this time Mr. Boddie, a commercial traveler in dry-goods, the chronicler of these adventures, met Mr. Shotwell, and they joined forces. A number of Boddie's friends went to Ajo in April 1900 to look at the mine. At that time Ajo was a station on the stage-coach route between Gila Bend and the Mexican border. The claims that Shotwell wanted to sell were named the Butte, Mainstay, Sulphide Stringer, and Quien Sabe. He held them under option from Childs, Stout, and Westbrook. The price was $19,500, part cash and part on time. The deal was consummated. The 10-stamp mill was started during the visit of Boddie and his friends, in order to show how easily the ore would be concentrated. The ore assayed 5% in copper; and the concentrate, 45%. All the visitors were innocent of experience in mining. As Boddie says: "The work looked simple and easy." This remark is interesting if viewed in the light of later events. On May 1, 1900, Boddie and his friends met at St. Louis and organized the Cornelia Copper Company, which owes its name to Mr. Boddie's wife, "who passed through the golden gate in the early morning of her beautiful womanhood." The capital stock of the company consisted of 100,000 shares of $10 each, a small part of which was offered to the friends of the promoters at $2.50. Thus $35,000 was raised. This was spent in sinking a shaft 228 ft. deep on the Quien Sabe claim and another shaft 125 ft. deep on the Mainstay. The samples that had been taken to St. Louis for assay came from holes, ten to twenty feet deep, made in the course of assessment work. The results of this prospecting by means of the two shafts proved disappointing. Let me quote Mr. Boddie: "When this $35,000 was spent, it began to dawn upon us that we were out of our element in the mining game and that we had no ore of consequence so far developed for concentrating and no water to run a mill even if we had; and also that Shotwell's way of managing a property was not in keeping with good business methods and he was solely bent on developing his own property he had under option, above mentioned, at the expense of the Rescue and Cornelia companies, and to continue organizing other companies adjoining the big 'Water Melon' in the patch he always termed Copper Mountain." Shotwell made $6,500 on the Cornelia deal and used it on his other options. He seems to have been an enterprising person. The Cornelia Copper Company decided to patent its claims and cease operations, pending developments on the adjoining properties. Meanwhile Shotwell sold most of his stock in the Cornelia and Rescue companies, and proceeded to organize a fourth company, the Shotwell Tri-Mountain Copper Company, with a nominal capital of 10,000,000 shares of $1 each. Of this stock Shotwell took 6,000,000 shares for himself and of the remainder he offered 400,000 shares at 20 cents, with a commission of 20% and a bonus of one share out of his personal holding.

Just then a man named Fred L. McGahan appeared on the scene with a vacuum-smelting process. The stage was well set for a mining vaudeville of the conventional

type. Each company was eager to have a vacuum smelter, the Rescue management being the lucky (?) one to win McGahan's services first, then the Cornelia, and lastly the Tri-Mountain. On the strength of an anticipated metallurgical miracle the stocks of all three companies found a market among the unsophisticated. The date was 1906. All seemed to be going well, especially for Shotwell, who sold enough of his wild-cat stock to buy the claims he had under option and to obtain control of the Ajo mining district. Unfortunately for him he became the victim of a delusion; he played with spiritualism and succumbed to the devices of a notorious medium. McGahan likewise consulted the spirits and attended seances held at Shotwell's house in New York, to which city he had moved. He and McGahan became jealous of each other's relations with the medium, a Mrs. Thorp, and a bitter personal quarrel ensued. The news of Shotwell's vagaries became known through lurid articles in the daily press, and his financial credit was ruined. He was unable to meet his part of the last payments due on the Tri-Mountain property, whereupon the Rescue and Cornelia companies paid the $22,500 that was due from Shotwell to the owners of the Tri-Mountain property, together with their own share of the purchase price. Shotwell brought suit to recover, but failed. Meanwhile the vacuum smelter was finished and ready to start, one at Ajo and one at Los Angeles. When the day for blowing-in arrived, McGahan decamped to San Francisco, and from there wrote to say that he would not start the smelters until he had been paid all the stock due to him together with a sum in cash. Then, as Boddie records, "the officers of the Cornelia and Rescue companies realized that they had been buncoed and flimflammed to a finish." They had. The disappointment was intense. "Mr. Neeley wired his wife that unless she would promise him never again to mention McGahan and the vacuum process, he would not return home but go west." C. E. Neeley, of the South Arkansas Lumber Co., was vice-president of the Cornelia company, which, it must be added, profited from the McGahan connection to the extent of using his wonderful smelter as an aid in selling its stock, the price of which rose from $2.50 to $6 per share.

Turning to the 'Copper Handbook' for 1907, I find that its author, Horace Stevens, an excellent chronicler and a veracious recorder, says of the Cornelia Copper Company that "it claims to have in sight 25,000,000 tons of ore, averaging 10% copper, with gold and silver values, *which is an excessive estimate.*" The italics are mine. He quotes from the company's prospectus, in which there appeared a lot of bunkum by McGahan anent his so-called vacuum process. The prospectus concluded with this statement:

"Enough has been said to convince the most skeptical that the inventor, Mr. F. L. McGahan, is not only an inventor, but a metallurgical scientist of national repute." He soon became recognized as a fakir of national notoriety. His own description of the smelter begins thus:

"In treating and smelting mineral ores and iron in a vacuum, the nitrogen in the air is excluded from coming in contact with same, practically eliminating all slag and the necessity of fluxing; furthermore none of the vapors or fumes being allowed to escape, the full values contained in the ores are secured, thus every bit of carbon and other volatile substance forming fuel quantities uniting with the pure ox-hydrogen, whereby great economy is secured in the reduction of all ores."

It is delirious nonsense, of course, and written in the language of a cub reporter, but it seems to have impressed the copper operators at Ajo. One may ask how he could exclude the nitrogen of the air by means of his vacuum and still retain the oxygen and hydrogen, or "ox-hydrogen"—a bovine compound—to unite with the carbon et cetera. Our old friend Stevens remarks:

"These most remarkable discoveries by Prof. McGahan are nothing less than epochal. At a single blow Prof. McGahan has demolished the entire fabric of chemistry and physics, built up with such painstaking labor during the last two thousand years . . ."

In the next volume of the 'Copper Handbook'—that for 1908—he says:

"The smelter proving an inglorious failure after costing $30,000, McGahan was arrested, and a nephew of McGahan's was shot three times, while trying to dismantle the plant. The Cornelia Copper Co. sued McGahan for damages, and had him indicted criminally, in May 1907, on three counts, for obtaining money under false pretences."

He proceeds to relate the further vagaries of the company:

"Having lost considerable money through the McGahan fiasco, the company, nothing daunted, turned to another new and untried process, invented by an electrician named Anderson, which is claimed to have been in use more or less successively for four or five years, though specific evidence on this point seems lacking."

At the end of the entry dealing with this company, he says, charmingly:

"The officers of the Cornelia are residents of St. Louis and vicinity, of excellent local standing, and perfectly sincere in their operations, but are totally lacking in practical knowledge of the copper business, and prone to overmuch experimentation with new processes."

At that time the president of the company was George H. Augustine; the secretary, John H. Boddie; and the treasurer, C. W. Chamberlain. According to Stevens, the company was organized on May 14, 1900, under the laws of Arizona, with a capital of $1,000,000 in $10 shares. This nominal capital was increased on February 19, 1907, to $3,000,000 in $10 shares, on the occasion of the absorption of the Rescue company.

How the stock was sold is described by Mr. Boddie. The leading salesman, M. E. Chamberlain, traveled from town to town; he would induce the citizens of a town to select a representative, who would go to the mine on the understanding that the expenses of the trip would be paid in the event he did not find things as represented. "When on the ground [he would] have him select an average sample of carbonate ore from Copper Mountain; pound it up to a powder in a mortar; put in nine parts water and one of sulphuric acid, which would convert it into copper sulphate, a dark blue liquid, into which the prospective buyer would be asked to insert his penknife blade, and when withdrawn it would be coated with copper. After this Mr. Chamberlain would add some zinc shavings, and the acid leaving the copper solution would attack the zinc, precipitating pure flakes of copper." This performance would be repeated a sufficient number of times, on different samples, until "the visitor was thoroughly convinced of the value and the magnitude of the copper in Copper Mountain". To the novice it must have seemed a convincing experiment. One wonders why Mr. Chamberlain did not put an M.E. after his surname, as well as in front. Presumably the powdered ore was removed

from the mortar to an acid-proof container, such as a glass beaker, otherwise it (the mortar) would have been "converted" into something new and strange. Mr. Boddie states that after the visitant representative of the citizens of a town had seen this pretty performance he was introduced to McGahan, who told him his own story of the marvelous vacuum smelter. That finished him; he would return home with a report that "the half had never been told" concerning this wonderful enterprise at Ajo. "And then began the buying of stock by everyone in the town that could raise a dollar."

In 1906 the Cornelia and Rescue companies, each owning 80 acres and each the possessor of an undivided half-interest in Shotwell's former Tri-Mountain group of claims, became involved in a disagreement over a division of their properties. The result, after an arbitration, was that the Cornelia absorbed the Rescue company, and with it the half-interest in the Tri-Mountain, thereby becoming the owner of 243 acres, of which 79 were patented. The capital of the Cornelia Copper Company was increased from $1,000,000 to $3,000,000, as already stated.

An effort was made to meet expenses by running the old stamp-mill while steps were being taken to patent all the unpatented claims; but the lack of water crippled the milling operations so that it was impossible to make both ends meet. Boddie's associates had become so disgusted and disappointed by their experience with charlatans that they were unwilling to find the money needed to put the enterprise on its feet. In 1910 an option on the property was given to the General Development Company and the Cornelia company was re-organized as the New Cornelia Copper Company, under the laws of Delaware and with a capital of $6,000,000, but this swelling of its nominal capital did no good. The General Development Company spent $12,000 in drilling a few holes and in doing a little surficial prospecting, but no business resulted. A number of well-known mining engineers visited Ajo and examined the property, including Messrs. John Hays Hammond, J. Parke Channing, and A. Chester Beatty; but they appear to have reported adversely. Some of the shareholders took a contract to treat the ore by the Anderson electrolytic process, and an experimental plant was built at the mine at a cost of $20,000. It produced about 2,000 pounds of copper at a cost of $1 per pound and then went the way of other metallurgic abortions. Thereupon the directors gave Boddie authority to dispose of the property. In 1911 John C. Greenway, manager for the Calumet & Arizona Mining Co., got into touch with Boddie, and this led to negotiations that ended in the transfer of the New Cornelia property to the Calumet & Arizona company. An option for two years was given, and was exercised on October 1, 1913. The option applied to 76% of the stock of the New Cornelia company. Vigorous and systematic prospecting with the aid of extensive drilling was started under the direction of Mr. Greenway as general manager and Louis D. Ricketts as consulting engineer. The operations were so successful that large masses of low-grade ore were soon disclosed. The earlier drilling had barely missed the largest orebody. Moreover it was ascertained that no zone of secondary enrichment existed, for the upper zone of copper carbonate and the lower zone of primary chalcopyrite and bornite did not differ in their copper content by more than 0.04%, and even this slight difference was on the side of the oxidized ore. The area included in the property is traversed by rounded hills, the copper-bearing portions being marked by a warm russet hue, caused by an excess of iron. Capt. Greenway as he was then, after the Spanish war (during the World war he was promoted to Colonel), started a series of laboratory tests with a view to leaching the oxidized ore with sulphuric acid and of concentrating the sulphide ore by means of flotation. Experimental plants of successively larger capacity, from one to 40 tons per day, were erected at Ajo. The results from 310 charges showed an average heading of 1.3% copper, an average tailing of 0.271%, an average extraction of 79.36%, and an electrolytic precipitation of 0.88 lb. per kilowatt-hour. In the summer of 1915 the construction of a branch railroad from Gila to Ajo was started, and it was finished in February 1916. Thereupon work was begun at once on a 5,000-ton leaching and electrolytic plant, which was put into operation in May 1917. In July of the same year the New Cornelia Company acquired the property of its neighbor the Ajo Consolidated Company. That is another story, to which I now come.

Soon after Shotwell and Boddie started work at Ajo, an option on an adjoining property, covering 135 acres, was taken by C. C. Bean, a mining operator of considerable experience. The 'Colonel', as he was called, took the option for $60,000 from the owners, who were in Philadelphia. He did a good deal of prospecting on the property and shipped considerable ore, but he needed working capital to make a mine of it. He tried to interest others in the venture, and many were the examinations that were made by the experts sent for that purpose; but in vain. At one time this property was under offer to the Cornelia and Rescue companies for $60,000, and the business went so far that $5,000 was deposited as earnest money, but the deal fell through. In January 1907 it was sold for $75,000 to the Randall Ore Reduction Company. Three years later Seeley W. Mudd, of Los Angeles, took an option on the property, but he did not exercise it.

In October 1912 Walter M. Briggs, son-in-law of James Phillips, Jr., and James P. Gaskill, formerly assistant-superintendent of the Nevada Consolidated Copper Co., were churn-drilling a copper deposit at Picacho, near Yuma, in Arizona, with the hope of finding leachable ore upon which to apply a metallurgic method devised by Utley Wedge. They had seen the treatment of the pyrite imported from Rio Tinto (in Spain), by roasting and leaching, at the plant of the Pennsylvania Salt Co. at Greenwich Point, near Philadelphia, and had a fixed idea that there was money to be made in the leaching of copper ores that could be steam-shoveled. While at Picacho, they heard through Ira B. Joralemon, geologist to the Calumet & Arizona Copper Co., of that company's operations in carbonate ore at Ajo. In consequence, Mr. Gaskill went to Ajo, where he was much impressed by the size and character of the orebody, and, after obtaining the names of the owners of the ground adjoining the Cornelia property, he telegraphed to Mr. Briggs, who had gone from Picacho to Boston. Briggs tried to obtain an option from the Randall Ore Reduction Co., but found that Greenway had preceded him. Thereupon he asked the owners to let him know in case Greenway failed to exercise his option, and they promised to let him know within a month, which was the period covered by the option. In due course they informed Briggs that Greenway had not exercised his option and that they

were willing to sell to Briggs, but not to give him an option, as they had promised Greenway to give no further option except to him. Thereupon Mr. Briggs made the purchase for cash, in behalf of Mr. Phillips, and registered the Ajo Copper Company. Mr. Phillips was one of the leading copper operators of the United States, he had been associated with the Nevada Consolidated and the Tennessee Copper companies. The churn-drill at Picacho was brought to Ajo, but it would not work—no churn-drill would—because the rock was so full of open fractures and of hard ground surrounded by soft, so that the drill lost its alignment. Greenway, thanks to his experience in iron-ore mining, had avoided this trouble. Then Gaskill, who was in charge of the work for the Ajo Copper company, engaged E. J. Longyear & Co. of Duluth to diamond-drill the property under contract, at first for $2.50, and later for $2.25, per foot. This was at the close of 1913. The drilling proved a well-defined enrichment along the contact of the ryolite and the monzonite, although Mr. Joralemon has laid emphasis on "the association of the ore with the normal coarse-grained monzonite", in his Institute paper of 1914. It was also shown, by the diamond-drilling, that the ore-bearing ground extending from the Cornelia into the Ajo ground, and that it became richer in its dip south-eastward. The dimensions of the orebody became established in 1914. At that time Mr. Phillips obtained an option on the Childs group of claims, which formed a wedge between the Ajo and the Cornelia. This option was assigned to the United States Smelting, Refining & Mining Co., which tried churn-drilling, only to obtain some useful experience. The option was dropped. Nothing much was done until the resumption of diamond-drilling on the Southern claim proved that the main orebody made a bend around the southern end of the Childs property into the Ajo ground. This demonstrated the great value of the latter, the drilling indicating 11,000,000 tons of 2¼% copper ore. Included in this estimate were several bores that showed 4 to 7% ore. From the beginning of this exploratory work on the Ajo property, an old 10-stamp mill (probably the one erected by Shotwell), with a Wilfley table, was used to treat some of the high-grade ore, the resulting concentrate being shipped, with hand-picked ore, to the smelter at Bisbee. In this way about 15,000 tons of concentrate and selected ore, together averaging 45% copper, was produced. The showing was so good that the controllers of the New Cornelia were wise in acquiring the property, which was done, as I have stated, in 1917, by which time there had been proved 21,000,000 tons of 1.5 per cent ore.

Of the later story of this great enterprise I shall say no more at this time except to add that its recent development exemplifies the play of those factors of technical knowledge and business sagacity that were so conspicuously lacking in the tale that I have told of its early vicissitudes.

Bauxite in 1922

The domestic production of bauxite in 1922 was at least twice as large as in 1921 and may reach a total of not less than 300,000 long tons, according to James M. Hill, of the U. S. Geological Survey. This quantity is about half of that normally consumed, yet the increase in output is encouraging, for it reflects a larger demand by all the consuming industries, particularly the abrasives industry. The operations in the Arkansas and the eastern fields were larger than in the preceding year.

Equipment of Fluorspar Mines

E. C. Reeder, in the *M. C. M. Alumnus*, describes the equipment of the three larger fluorspar mines in southern Illinois. As none of the mines is over 620 ft. deep, the hoisting equipment required is not large. The Hillside mine has a Nordberg double-drum electric hoist, hoisting a three-ton skip in balance with cage. This hoist has cylinder drums 5 ft. in diameter and is geared to a 150-hp. General Electric induction motor. At the Rosiclare mine they hoist three-ton skips in balance with a double-drum twin Nordberg hoist with 18 x 42-in. cylinders and conical drums 7 to 9 ft. in diameter with a 4-ft. face. The Fairview mine uses one-ton skips and Lidgerwood steam geared hoists with 10 x 12-in. cylinders and 4-ft. drums at the Goodhope mine and 1½-ton skips and a Lidgerwood 12¼ x 15-in. geared steam hoist at the Extension mine.

The rock-drilling equipment is pretty much the same at all three mines. Sinking is done with the jackhammer type of drill, drifting and crosscutting is generally done with a mounted machine, sometimes a jackhammer where the ground is not too hard and a Waugh turbo type where more power is needed. Stoping is all done with air-feed hand-rotated stoping machines.

Practically all the well-known makes of drills are in use in the district.

Pumping equipment is of great importance, as the mines are wet. The Rosiclare mine has on the 420 level a compound condensing Prescott 14 x 26 x 10 x 24-in. pump and on the 520 level a triple-expansion condensing Prescott pump, 10 x 15½ x 26 x 8¼ x 24; this is extra heavy with pot-valve water ends. Both of these pumps throw to the surface, and in addition they have a number of smaller pumps.

The Fairview mine has in the Goodhope pump station the following pumps: one compound condensing Prescott 1,000-gal. capacity, one compound condensing Prescott 500-gal. capacity, one compound condensing Worthington 1,300-gal. capacity and one Cameron steam turbine driven centrifugal of 1,000-gal. capacity. Both of these mines are deeper than the Hillside mine, which is enjoying the benefits of mining in drained territory.

Under normal conditions the Fairview company pumps some 1,500 gal. per minute and the Rosiclare company about 700 gal. per minute, but in times of high water in the Ohio River the flow of water increases to double these figures. All these mines have steam power plants and coal is supplied either by rail from southern Illinois coal fields or by barge from the Ohio River from west Kentucky.

To produce the commercial grades of spar demanded by the market it is necessary to mill the run-of-mine ore. The flow sheets of the modern spar mill are substantially the same, the operations being jigging and table concentration.

The "gravel" spar is usually shipped to the steel mills for fluxing purposes and the lump spar is shipped either as lump for use in foundries or is ground to pass 24 mesh, as required in enamel manufacture, glassware, porcelain glazing, and like uses. It is customary to grind fine enough to pass 55 mesh for the production of hydrofluoric acid, sodium fluoride, and other chemicals.

The standard specifications for gravel spar call for calcium fluoride 85 per cent, and silica not over 5 per cent; lump for foundry use and enamel ware, calcium fluoride 95 per cent, silica not over 3 per cent; lump for acid, calcium fluoride 98 per cent, silica not over 1½ per cent.

Manganese Deposits of Lunenburg County, Nova Scotia

Shallow Mines Situated in a District of Flat Glaciated Topography and Sluggish Drainage—Origin of Manganese Found in Sedimentaries Formerly Covering Area

BY FREDERICK C. FEARING
Consulting Mining Engineer, Philadelphia, Pa.

F. C. Fearing

TO SAY that any of Nature's handiwork is ever "freakish" may appear on first consideration either paradoxical or at least based on gross misconceptions. However, now and then one comes across results caused by such a unique combination of natural circumstances that the use of the epithet seems not only pardonable but even advisable. The fact that freaks do occur ought to be recognized, and heeded as a warning to stop and consider, and should give pause especially to the all-too-common type of investigator who takes pride in snap decisions. Many are the surprises in store for the "tack-hammer" geologist and half-baked mining engineer and those who employ them.

In the foregoing philosophical outburst, followers of E. Phillips Oppenheim may amuse themselves by deducing some of the motives behind this article.

The manganese deposits to be described are in central-western Nova Scotia, in the extreme northern corner of Lunenburg County. They are approximately halfway between the head of the Bay of Fundy, to the northwest, and the city of Halifax, to the southeast. The supply base and nearest railway point is Falmouth, twenty-six miles by wagon road to the north, with the port of Windsor a mile or two miles beyond. The geographical relationships are shown on the map, Fig. 1. All supplies, except timbers, must be imported. There are no habitations anywhere near the mines, and the whole country round about is still a wilderness and the refuge of moose, bear, and smaller animals and many varieties of birds.

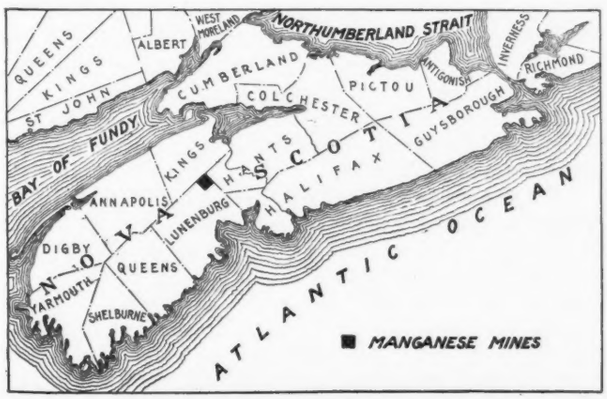


Fig. 1.—Map of Nova Scotia

The region was studied in the fall of 1921, in the course of which a large number of rock specimens were collected and afterward examined minutely, under the microscope and in the chemical laboratory, by Dr. Alexander N. Winchell, at the University of Wisconsin, Madison, Wis. This phase of the investigation was of the greatest value in solving many important problems encountered.

COUNTRY OF LOW RELIEF

The country is characterized by a number of extensive, glacier-formed swamps through which low, rounded hills of granite protrude. The mean elevation is probably between 400 and 600 ft. above the sea. So low is the relief, however, that a knoll rising 100 ft. above the marshes would be a prominent landmark. The area is thickly strewn with glacial drift, consisting entirely of granite, and many of the individual boulders are of great size.

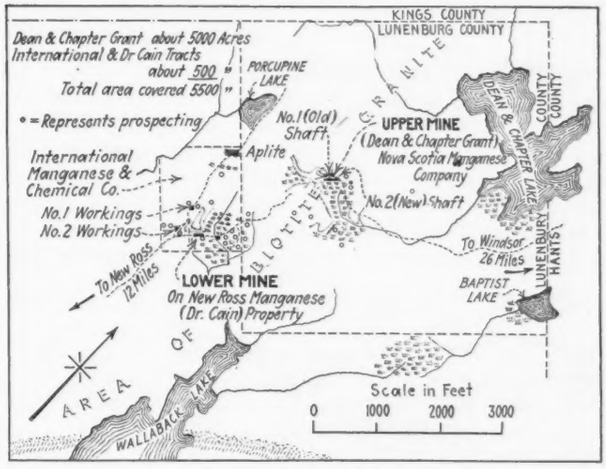


Fig. 2.—Property map

In such a country the geologist ought to become profoundly impressed, as soon as he enters it, with the sluggishness of its drainage and with the resulting thought that if the tonnage of the ores should be found to depend largely upon the depth to which oxidation and leaching can penetrate before being stopped at the level of stationary ground water, then, indeed, the deposits must necessarily be extremely shallow.

The property map, Fig. 2, shows the location of the three main groups of workings, known, respectively, as the Upper, or Dean and Chapter mine; the Lower, or Dr. Cain mine; and the No. 2 workings, on the International Manganese & Chemical Co.'s tract. The two latter are without doubt on the same fracture zone, but the former is on an entirely different one.

Of these, the Upper mine alone is reported to have ever made any money for its operators. The ore here is pyrolusite (MnO_2), whose unusual purity led to the expenditure of large sums of money on these properties in

recent years in the belief that great bodies of similar, high-grade ore existed on them. Subsequently, however, the known available tonnage at the Upper mine was found to be disappointing, and has now been worked out. Fig. 3 represents a longitudinal section through the workings.

At the Lower mine, too, the orebody is small and in addition consists largely of manganite, the lower oxide of manganese ($Mn_2O_3+H_2O$), for which there is not nearly so attractive a market as for high-grade pyrolusite. So far as has been determined, hardly a dozen tons of ore was ever marketed from this mine. Fig. 4 shows the workings in longitudinal section.

The International Manganese & Chemical Co.'s tract has never contained any prospective commercial ore, and its No. 2 workings are of interest only because of

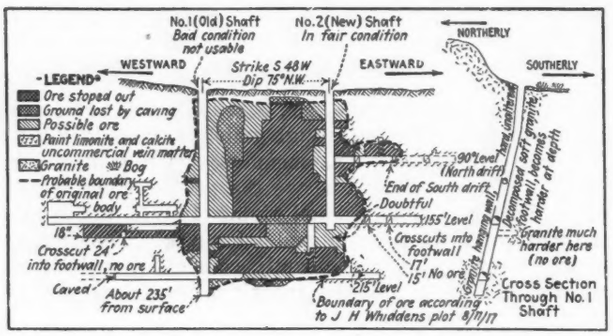


Fig. 3.—Upper mine, on Dean and Chapter grant

the light that they shed on the genesis of the deposits of the region. The mode of occurrence is as follows:

1. As disclosed in Fig. 2, manganese minerals are found on all three properties in almost vertical fault fissures, in granite. Granite is the only rock exposed anywhere near the mines. Small, aplitic segregations are extremely numerous, but large bodies are rare.

2. In all the mines, the mineral-bearing part of the

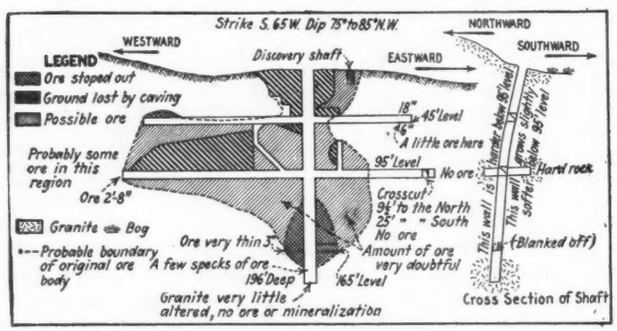


Fig. 4.—Lower mine, on new Ross manganese property

fissures is found at the foot of a pronounced granite scarp, which invariably forms the northwest wall of the fissure.

3. In all three properties, the outcrop of the lead is not only at the base of a scarp, but also on the very edge of an extensive bog, which stretches away to the southeast. In wet weather a portion is under water.

4. In all three properties, the manganiferous portions of the fissures are at or near an important center of drainage. In other words, waters from higher areas of the granite surface, mainly to the west and northwest, move in channels such that a large portion of them, at least, are discharged into the swamps along or across the fissures at points where the latter are directly in contact with and form an integral part of the bogs themselves.

5. Although the zone of fracturing is extensive and from 25 to 100 ft. in width, in all three mines by far the greatest deposition of manganese has taken place along the northwest wall, which forms the scarp previously mentioned. This is so, regardless of whether that wall is a footwall or a hanging wall.

6. Surprisingly little water comes into the workings. At the Upper mine, with its seven or eight hundred feet of development and numerous stopes, the sump of No. 1 shaft fills at the rate of hardly 60 gal. per minute, even in wet weather. At the Lower mine, which has considerably less development, water nevertheless accumulates somewhat faster than at the Upper mine, probably because the shattered region is here distinctly more open. However, in all properties the water rate is so small that it seems unlikely that the manganese has been deposited in any extensive, open fault zone, suitable for the formation of large orebodies—especially in view of the location of the workings beneath a bog and the further fact that the fissure filling is frequently notably porous.

In all three instances the composition of the deposits is extremely simple. Usually, a small iron capping marks the outcrop for a short distance, carrying enough manganese to impart a characteristic purplish tone. A capping of this color is locally called "paint." The hopeful belief that wherever there was paint there was a deposit of manganese ore lower down has been exploded, for, although dozens of paint patches have been prospected by trenches, pits, and shafts, only in one or two instances has anything even remotely suggesting ore been found beneath them.

Pure Grades of Manganese Found

The ore at the Upper mine is coarsely crystalline pyrolusite, manganese dioxide (MnO_2), for the most part of unusual purity, the better grades being well suited for use even in the most exacting chemical trades. Unfortunately, some of the best of it is likely to contain small lenses, seams, or pockets of iron oxides, which render a large portion of the orebody too impure for shipment as high-grade material. Evidently, slight changes in conditions affecting the relative solubility of iron and manganese frequently took place locally in the fissures during the period of ore formation. The pyrolusite often shows nodular structure as well as pseudomorphic evidence of zonal growth.

The principal minerals are oxides of iron and calcite, the latter being either distinctly ferruginous and reddish or else pure white. Generally speaking, the former is the older. It is especially plentiful near the limits of the orebody. This appears to be so generally true that increasing amounts of it have come to be looked upon by the miners as a sure sign that the limit of the shoot is close at hand. At other times the calcite may be distinctly manganiferous.

As to the other associated minerals, only a subordinate amount of quartz was noted, as a constituent later even than calcite. No sulphides were discovered in the vein material, though sulphides are known to occur in the country rock, nor were any of those primary minerals usually observed in veins in granite, such as rhodonite and rhodochrosite, nor any species suggesting that hydrothermal, pneumatolytic or the action of cold aqueous solutions, traveling laterally through the granite

Portion of surface, showing No. 1 shaft (left) and No. 2 shaft (right) at Upper mine in distance

and coming up from below along the fissures, had played any part in the history of the deposit.

What has just been said about the Upper mine applies also to the Lower mine, with some slight modifications. At the latter place, the ore, although pure, is manganite, the lower oxide of manganese ($Mn_2O_3 + H_2O$). The amount of calcite is also notably greater. Furthermore, the orebody is undoubtedly much smaller. The elevation of the outcrop is about 60 ft. below that of the Upper mine. Evidently, conditions governing ore formation at the Lower mine were less strongly oxidizing than where a pyrolusite orebody was created.

At the No. 2 International workings, the fissure filling consists of calcite and iron minerals with subordinate amounts of manganese oxides. Conditions governing ore formation here must have been far less oxidizing than in the other two deposits.

It is interesting to note from the foregoing description that just as increasing amounts of calcite in the local individual workings indicate fading out of the ore, likewise, on a larger scale, a similar increase in the general abundance of this mineral at one property as compared with the others is accompanied by a decrease in oxidizing action and a corresponding lowering of the grade and relative amount of ore present.

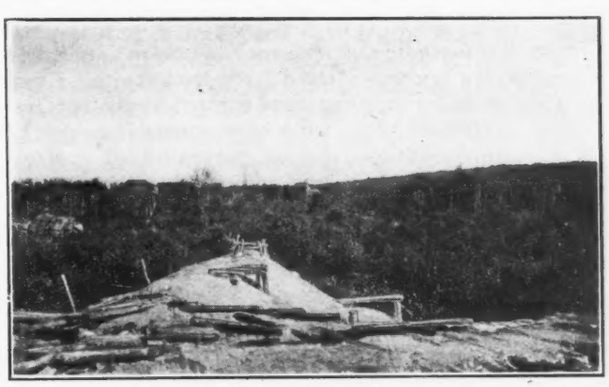
Examination of specimens of wall rocks from the fissures show that the feldspars have been attacked by solutions that first deposited lime carbonate along fracture planes, with later introduction of iron and manganese oxides. The successive alteration is distinct and plainly in this order and is clearly related to the fracture planes, being most distinct in and fading gradually away from them. At the International No. 2 workings, the microscope showed a similar secondary replacement of the earlier calcite by iron and manganese, but it also showed, in addition, some manganese oxide so disseminated through the calcite that it may have been produced at the same time, or by later alteration. The generally intermittent character of the mineralizing conditions is again vividly illustrated, this time by a calcite crystal showing eight growth layers.

Examination of samples of the older carbonates from different portions of the properties invariably disclosed a manganese content, varying from 0.5 to 3 per cent. These results were obtained by Dr. Winchell through the use of the comparatively new index-of-refraction method, checked by qualitative blowpipe tests.

At the bottom of the Lower mine shaft, 196 ft. from the surface, the lead consists merely of partly altered porous granite. The plagioclase has been strongly attacked, the orthoclase much less affected, and the biotite affected hardly at all. Commercial ore appears to have faded out rather suddenly near the 180 level (see Fig. 4.), the load becoming more calcitic and ferruginous, with here and there a small nodule of manganese. The deposit has many features common to those formed in bogs.

At the Upper mine, also, commercial ore vanishes quite suddenly about 215 ft. from the surface, but a little continues downward locally in No. 1 shaft. Below the 215 level, the lead is characterized by quantities of calcite and iron oxide, in which occasional "niggerheads" of more or less impure manganese and iron ore occur. These conditions are well illustrated in Fig. 3. As in the Lower mine, the deposit here exhibits many of the peculiarities of bog formations, and even the purer ore gives frequent evidence of having grown into a solid mass by accretion and gradual enlargement of numerous nodules, as well as by replacement of the calcitic materials by manganese-bearing solutions.

Recalling what was said in the opening paragraphs of this paper about topography and sluggish groundwater circulation, it is interesting to find that the lower limits of both the Upper and the Lower mine orebodies are at nearly the same elevation above sea level. Also, topographic conditions at the Upper mine would be



View from dump No. 2, International workings, Lower mine in distance

expected to result in a somewhat faster water circulation, and the presence of predominant pyrolusite is therefore not surprising. Nor is one to consider unusual the predominant manganite—the lower oxide of manganese—and greater quantities of carbonate at the Lower mine, and still less remarkable is it to find mainly carbonate and comparatively little manganese oxide at the International No. 2, where the local relief is down almost to the level of the swamps themselves, and where the circulation of underground water must be the most sluggish of all.

Prospecting over a wider area might reasonably receive some encouragement if it could be shown that the manganese was derived from the granite rocks, either as a phase of magmatic activity or by lateral secretion at a later date, the final course of the mineralizers in either case being upward along the fissures. Under such conditions, any of the earlier shattered zones in the granite would have a chance of containing orebodies. Inasmuch as several previous investigators assumed that this was indeed true and that the biotite, being the only manganese mineral present, was the actual source of the ore, this point had to be definitely settled. Numerous fresh samples of granite were therefore taken by blasting, one set being obtained along the fissures near each of the leads and the second set several hundred feet away from them. Careful microscopic and chemical studies of these specimens showed the following:

1. The biotite is the only mineral present in the granite that contains any manganese.
2. The biotite remains fresh long after the other constituents have been completely altered. In the few instances where the biotite has been attacked, no manganese minerals whatever were formed.
3. In the vicinity of the fissures, the granite shows no signs of alteration. The biotite is completely inclosed by minerals which are themselves compact and unaltered.
4. Sulphide occurs in minor amounts in the granite.
5. At the surface the manganese content of the granite, although highly variable, averaged 0.22 per cent, as compared with 0.13 per cent in the average granite, but at depth, as, for instance, in the bottom of the Lower mine shaft, its manganese content was normal and the biotite still lustrous, even though directly in the path of whatever mineralizers had traversed the fissures. The granite shows no sign of any impoverishment of its manganese content.

Sedimentaries and Not Granite Account for Source of Manganese

From the foregoing it appears that there is no evidence that the ore was derived from the granite. Even the wide variation in manganese content at the surface is hard to attribute to the work of solutions from depth, but is readily accounted for as the result of surface water activity. In short, the opinion that the granite is the source of the manganese must be discarded and attention turned to the sedimentary rocks which formerly existed in this region.

The oldest known rocks of Nova Scotia consist of a series of shales, sandstones, slates, and quartzites, having a total thickness of about 30,000 ft., known as the Goldbearing formation, but locally termed "Whin." These were doubtless deposited upon a slowly subsiding sea floor, probably before the end of early Cambrian time. Subsequently, except for a short period during the Silurian, erosion of the Whin went slowly but steadily forward until the intrusion of the granite brought about a great regional uplift in the Devonian. The Whin now stands generally at a high angle, crumpled, twisted, and faulted, bearing witness to the revolutionary changes in the character of the landscape that took place at that time.

Although we do not know how far upward the granite actually penetrated toward the then-existing surface of the intruded sediments, it is certain that it cooled slowly and must therefore have done so while deeply buried. Its unusually coarse, porphyritic texture is widespread, especially in the region of the manganese mines. In spite of this, however, so intense was the erosion that followed its upward course that, by the end of the Devonian, the overlying rocks had been largely removed and the granite itself subjected to the agencies of weathering. The basal portion of the Horton series, laid down near the very end of the Devonian, is composed in some places of an arkose derived from granite.

Small pockets of secondary manganese ore of inferior grade have been found occasionally in remnants of the Whin, but it seems unlikely that such deposits could have accumulated during Devonian time in the face of the erosion just described, and least of all in the region of the present deposits, where this erosion was probably severe. The source of the manganese should therefore be sought in still younger rocks.

Following the granite intrusion, alternate submergence and elevation of the land occurred in Nova Scotia. Transition from the Devonian to the Carboniferous is represented by the Horton series, already mentioned. The Carboniferous itself is well represented by rocks of considerable thickness, and Permian, Triassic, Pleistocene and Recent formations have also been identified. With the exception of the Carboniferous strata, it is doubtful if any on this list ever overlaid the Lunenburg region to any important thickness, and, moreover, they have not yet produced any manganese prospects worthy of notice.

Other Mine Workings Give Valuable Indications

The Carboniferous, however, is of decided interest, because in it are found a considerable number of the better manganese prospects, as at Walden, Tennycape, and Truro. They probably once overlaid northern Lunenburg County to an appreciable thickness. Furthermore, in view of the occurrence of manganiferous calcite as one of the earliest of the vein minerals at these mines, the existence of a great deposit of ankerite —carbonate of iron, manganese, calcium, and magnesium—in Upper Carboniferous rocks is significant. The occurrence alluded to is near Londonderry, Colchester County, and has been worked as an iron mine for a number of years. According to the Canadian Bureau of Mines, it is from 30 to 150 ft. wide and has been traced for a number of miles. It is not far from the coal measures, and indicates that conditions governing its early history were, as at the Lunenburg deposits, reducing rather than oxidizing.

It appears, therefore, that the Carboniferous rocks, upon weathering, would be easily capable of supplying the manganese of the granite fissures and influencing its original deposition in them in intimate association with calcite. Indeed, these rocks are the only ones of post-granite age in which the evidence in this connection is other than strongly negative, and it is there-

fore concluded that they are the most likely source of the ore.

During Pleistocene time, three distinct periods of glaciation affected the Lunenburg deposits, planing off their outcrops and dissipating an unknown but probably considerable portion of the manganese. The last phase of the glacial activity had a local movement of S. 17 deg. E. Considerable float has been found in this direction from the outcrop of the Upper mine, on high, well-drained ground, mingled with coarse drift. Even before that, however, erosion had probably removed the last remnants of the overlying sediments and had brought the ores to the beginning of the final chapter in their history. Today, they are in an advanced stage of geologic decadence.

Conclusions

Before closing, it seems advisable to collect and summarize the various facts heretofore brought out:

1. The known orebodies are all small.

2. The ores are entirely secondary and are due to surface solutions descending within fissures in granite.

3. The source of the manganese cannot be found in the granite, but must be sought in younger rocks, probably in Carboniferous sediments, which formerly existed in this region but have long since been eroded away.

4. The ores were formed at certain points along previously existing fault fissures. While the manganese-bearing sediments, which once overlaid the granite, were undergoing erosion and weathering, surface waters dissolved out their contained manganese, subsequently sank to the underlying surface of the granite, and then followed the drainage system of the latter, with respect to whose regions of discharge a small portion of the fissures happened to be favorably located. Precipitation of the dissolved metals then took place at these favored points along the fissures. These points were therefore predetermined, in part by the topography and the fractures of the granite, and in part by the local condition of the fissures themselves.

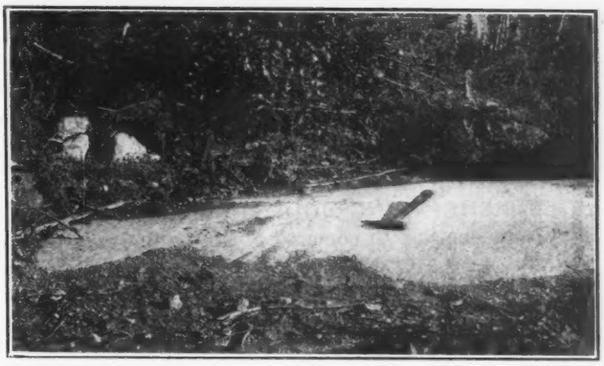
5. Deposition of the metals occurred largely as carbonate, but some pure calcite was also formed, probably from solution and reprecipitation of the limestone of the Carboniferous formations above, as well as from weathering of the feldspars of the granite walls of the fissures.

6. As weathering continued to act, the manganiferous vein matter became further concentrated and purified with each cycle of oxidation, solution, and reprecipitation, as dioxide or sequioxide, according to whether the conditions were more or less strongly oxidizing.

7. As erosion advanced, conditions within the fissures became more and more like those found in bogs, and the deposit slowly increased in size and purity, partly through the growth of nodules of manganese ore, but at a still later date glaciation dissipated a large amount of the surface portions of the occurrences.

8. Controlled as they have been by the effects of weathering, commercial quantities of ore will not be found appreciably below the level of the hermetic barrier of stationary ground water. This depth was reached at the Upper mine about 215 ft. from the surface and at the Lower mine about 180 ft. from the surface.

9. The outlook for finding new bodies of commercial manganese is considered discouraging. Except where ore has already been discovered, the outcrops of the known fissures are not favorably situated with respect to the topography and drainage system of the granite. Indeed, the most careful prospecting has failed so far to disclose any new deposits of consequence.



Glacial striae. The pick handle is pointing S. 17 E.

In view of all the evidence as to the genesis of the Lunenburg manganese ores, and the large number of variable and unusual factors entering into the matter, the reader will now be asked to recall the opening paragraph of this article and to judge for himself of the propriety of classifying these deposits as coincidences —as freaks, geologically speaking—which are unlikely in the extreme to be duplicated anywhere within the granite region of Nova Scotia.

South Africa a Better Market for American Mining Machinery Than Before the War

The following table, published in *Commerce Reports* for Dec. 18, employing the figures for mining machinery furnished by the official import statistics of the Union of South Africa, shows the total value of imports of mining machinery for each of the years indicated and also the values of the imports from the United States and the United Kingdom in the corresponding years:

MINING MACHINERY IMPORTED

Countries of Origin	1913	1918	1919	1920	1921
United Kingdom	£511,968	£292,123	£303,350	£419,376	£554,564
United States	161,191	271,730	405,523	194,855	347,001
All other countries	92,827	5,595	6,503	4,015	38,970
Totals	£765,986	£569,448	£715,376	£618,246	£940,535

The value of imports of mining machinery in 1921 exceeded those of 1913 by more than 20 per cent and show an appreciable increase over those of the intervening years. The most notable feature shown by these import statistics is the expansion which has taken place in the ratio of machinery imported from the United States. Despite the decided drop of imports from the United States in 1920, compared with those of 1919, the salient fact is that in 1921 the manufacturers of the United States supplied more than 35 per cent of the mining machinery purchased by the mines of the Union of South Africa, which is more than twice the proportion purchased from the United States in 1913.

Sufficient statistics are not available at present to indicate the value of the Union of South Africa as a market for mine stores and mining machinery in 1922, but it is probable that the totals will not reach those of the preceding year. It is known, however, that with the resumption of mining in the Union there will be a necessity for the mines to make extensive replenishments of their supplies. It is with this in view that United States manufacturers and exporters should plan for the opportunities which will be offered in 1923.

Sumitomo: A Japanese Anaconda*

Company Avoids Publicity, but Its Operations Have Extended Into Many Fields, and the Management Is Decidedly Progressive—The Besshi Mine a Producer Since 1691

FOR SHRINKING MODESTY about industrial success one has to come to Japan to find a group of conservative, retiring, and reticent captains of industry whose enterprises are part of the story of Japan's advance and whose beginnings are lost in the dim pages of history. Their phenomenal rise in the past two decades equals, if not surpasses, many of the more widely known western names whose success is chronicled as part of modern progress. It is only through official reports, the occasional stories that appear in some Japanese publication, and by visiting the country, that one gathers an idea of the full extent of the operations of such concerns. The Japanese captain of industry is not talkative. He avoids interviews. In fact, when it comes to publicity about himself, he has nothing to say. The barrier of language keeps his fame within the boundaries of his own country.

Back in the closing years of the seventeenth century, when America was still the Thirteen Colonies and England was about to establish a national banking institution, a copper mine was discovered along the shore of the Inland Sea of Japan and was opened and worked by the lucky discoverer. So was born the house of Sumitomo, a name to conjure with in present-day Japan. From this beginning, 232 years ago, has grown one of the most important enterprises of the world, which today operates with a total capital of nearly 250,000,000 yen ($125,000,000) and controls copper, gold, silver, coal, and iron mines; smelters, refineries, tube, wire and nail factories; fertilizer and lumbering enterprises; warehouses, steel works and a bank with 70,000,000 yen capital, having branches in all the principal cities of Japan and the Far East, as well as in London, New York, Bombay, San Francisco, Honolulu, and Seattle.

For nearly two centuries the firm of Sumitomo confined its activities largely to the development of its mining interests, carrying on the work with unwearied research and scrupulous adherence to a code of business ethics which won for its products the highest place in the copper markets of Japan, and, as time passed, in the outside world. With the growth of the mining business and the accumulation of profits, the house of Sumitomo branched out into banking, advancing large sums to the Daimios under the Shogunate, and the merchants of the city of Osaka, which was then gaining its prominent position as the center of commercial and industrial Japan. The Osaka of today, that great smoking beehive of Asiatic industry, was made possible, in part, through the civic pride of the Sumitomo firm, which for over two centuries has maintained its head office there and identified itself with the city's growth and prosperity.

With an output of 1,497 tons in 1698, the Besshi copper mine, on the Inland Sea of Japan, took its place as one of the world's great producers, a place it has held until now it is yearly treating about 233,000 tons of ore and producing approximately 3,000 tons of refined and 11,230 tons of electrolytic copper, with every indication that it will continue to produce indefinitely. The Sumitomo firm has opened a special office at Kobe for the export of its copper products, and with the progress of Japan and the expansion of the firm's activities, the selling organization has now its own offices in all the leading cities of Asia, and several in Europe and America.

In 1894, the firm bought out a copper-rolling concern in Osaka, and under the name of the Sumitomo Copper Works started to manufacture copper rods, plates, tubes, and wires from the output of the Besshi mine. Three years later, a branch factory was established at Nakanoshima for the manufacture of zinc plates and rods, and aluminum plates and wires. In November, 1895, the manufacture of insulated wires and electric cables was begun, and in November of the following year solid and drawn tubes were successfully turned out. Later a plant was erected to make large copper sheets, and a branch factory erected at Amagasaki for the manufacture of wire nails and galvanized wire. Constant improvements and the installation of the most modern equipment have maintained these plants at a high state of efficiency. The quality of the products has steadily advanced, being specified and approved for use in all Japanese government work, especially for the navy.

In 1894, the firm acquired coal properties in Kyushu, producing excellent coking coal from the Tadakuma mine, and from the Kiuragi mine some of the best steaming coal in Japan. The output of the two mines, which during the war reached 500,000 tons yearly, is now about 300,000 tons. In 1901, the firm entered upon one of its most important enterprises by purchasing the plant of the Nippon Steel Works, in Osaka, launching out as the first private steel works in Japan. These works have a melting capacity of 40,000 tons of acid and basic steel, which is converted into wheels, axles, rollers, shafting, cylinders, gear wheels, and ship and engine parts. Its products are approved not only by the Japanese Government but by Lloyd's for that corporation's A1 specifications.

In 1911, the wire and cable factory of the firm was made independent of the copper works under the name of the Sumitomo Electric Wire Cable Works, which is now capitalized at 12,000,000 yen, and is producing all kinds of electric wires, insulated and armored cables, and other conductors. In addition, a fertilizer factory was established in 1913 near the Besshi copper mine, where the ores are treated for their sulphur content, producing sulphate, nitrate, and super-phosphate, and compound fertilizers, which are sold direct to the farmers through the firm's own representatives in each prefecture.

In addition to the copper and coal mines, the firm has developed gold and silver mines in the Hokkaido, and it is expected that the proverbial luck of the Sumitomos will hold good and that these will also enjoy as wide a reputation as the copper properties.

At the head of these prosperous enterprises stands the energetic descendent of a long line of noble ancestors, Baron Kichizayemon Sumitomo, the younger brother of Prince Tokudaiji (formerly Lord Chancellor

*Abstracted from *The Far Eastern Review.*

to the late Emperor) and of Marquis Saionji, the last of the Elder Statesmen. He was adopted into the Sumitomo family in 1892 when twenty-eight years of age. In 1897 he set out on a tour of Europe and America. It was not the usual tour of the pleasure-seeking nobleman of other countries. His days were spent in visiting factories and mines, studying their organization, their ways of conducting business, and especially the methods for the promotion of the welfare and happiness of the workers. He was equipping himself for the huge task that some day he would be called upon to assume in directing the affairs of his house. Rarely, indeed, is the picture presented of the descendent of a long line of princes surrendering the ease of aristocratic surroundings and court life to enter the turmoil of business that he might better serve his nation and advance the well-being of his dependents. Soon after his return from this tour, he was elected to the House of Peers, but resigned to apply himself more closely to the development of the interests entrusted to his care. In 1911, he was created a baron in recognition of his services to the nation in advancing its industries. Since then he has devoted himself entirely to the management of the vast interests of the family with which he cast his fortunes.

The solicitude shown for the welfare of the employees by the head of the house is reciprocated by an intense loyalty that is probably not duplicated in any similar enterprise in the world.

The control of the vast Sumitomo enterprises is centered in a *honten*, or head office, under the name of the Sumitomo Goshi Kaisha, a limited partnership at the head of which stands Baron Sumitomo. For the management of the firm's enterprises there is a board of seven directors and three managers, who direct the affairs of the various enterprises and account to their head for all affairs of importance and see that his policy and instructions are rigidly observed. This central board is composed of the actual heads of the subsidiary companies. Its present composition will indicate the close working of the organization. The president is the head of the house, Baron Sumitomo. The directors are Masaya Suzuki (head director), who acts as general manager for the Sumitomo family. Here is a high type of Japan's executives, an experienced lawyer who resigned from the government service to accept the management of the Besshi copper mine, and is now chairman of the board of the Sumitomo Electric Wire and Cable Works and of the Sumitomo bank.

Mr. Kwankichi Yukawa, president of the Sumitomo bank, is undoubtedly one of the most brilliant financiers of the empire. Mr. Chojiro Kusaka is manager of the extensive warehouse system of the firm; Mr. K. Ohdaira is the general manager of the Besshi copper mine and Mr. Junkichi Matsumoto is general manager of the Sumitomo Copper Works. In addition, there is Mr. Tadateru Sumitomo, a member of the family, and Mr. Masatsune Ogura. The actual management of the head office is entrusted to three managers, Mr. M. Ogura, Mr. K. Honjo (who also directs the forestry and lumbering interests of the firm), and Mr. Naoji Hidaka.

Each department of the various enterprises has its own executive, who reports to his special director on the central board.

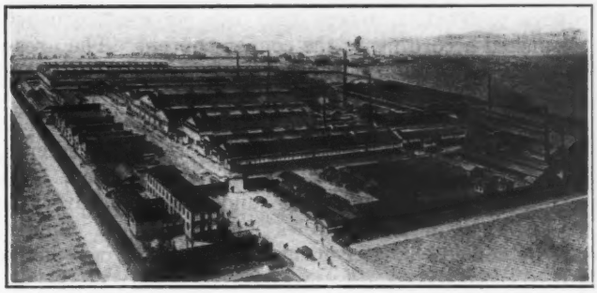
The old policy of the firm was one of self-centralization and conservatism which limited its scope of operations to Japan and its foreign business to copper ingots. Under the new policy initiated about a decade ago, and under the guidance of the new central board, it began to expand and keep in touch with world movements. Today, the Sumitomo activities cover the world.

Of the Sumitomo Besshi copper-mining office, at Niihama, Iyo, Mr. Komadzuchi Ohdaira is general manager, and Mr. Unosuke Okada is manager. The Mount Besshi concession covers over an area of about 7,000 acres, at 3,000 to 4,000 ft. above sea level, 12½ miles distant from the northern shore of Shikoku island. From its discovery, two hundred and thirty years ago, the output has been as follows:

BESSHI COPPER PRODUCTION

Period	Years	Refined Copper Produced. English Tons
1691-1867	177	43,508
1868-1877	10	12,933
1878-1887	10	25,454
1888-1897	10	48,094
1898-1907	10	49,216
1908-1917	10	78,600
Total 1691-1917	227	257,805

The annual output of ore is now, as stated, about 233,000 tons. When its output was about 1,499 tons, in 1698, this mine must have been the foremost on earth. In the middle of the nineteenth century, the output began to fall, but with the installation of improved and



The Sumitomo electric wire and cable works

better European methods for mining, transportation, and metallurgical treatment, a steady increase has been maintained.

The Sumitomo's refined copper, or "K. S. Ingot of Japan," has few impurities. The Besshi refined copper contains 99.7 per cent, and the electrolytic, 99.9 per cent of copper. It is specially suitable for the manufacture of brass and is sold at figures above the "B. S." brand on the London market.

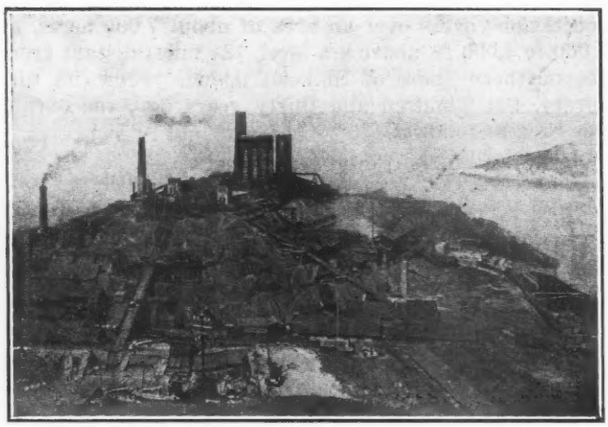
Geology of the Deposits

The geological formation of the Besshi mine is crystalline schist consisting of quartz-sericites and chlorite, between which lies the ore deposit, 5,000 ft. long and 2 to 25 ft. thick, outcropping at the height of 4,000 ft. above sea level. The present working point is 3,000 ft., at the deepest, below the outcrop. The ores are cupriferous iron pyrites, with an average of 3 per cent copper.

Conditions at the Mine

An inclined shaft is sunk 1,782 ft. along the dip of the ore deposit, starting at the outcrop and having crosscuts at every 260 ft., with eight levels. The shaft was sunk under the superintendence of M. Raloque, a French engineer, then in the service of the firm. There are two adits called "first" and "third" adits, and a fourth 12 ft. wide and 15,000 ft. long, and a blind vertical shaft, connecting the third and the fourth adit, 17 ft. in diameter and 1,950 ft. in depth.

Ores are excavated by overhand stoping; drills manufactured by the Chicago Pneumatic Tool Co., and rock drills of the Schramm and water-Leyner type, and one improved by Dr. H. Kudo, mechanical engineer of the firm, are used.



The Shisakajima smelter

The crude ores are carried out of the mine on electric trolleys to Tonaru, where they are screened, crushed, and picked according to the copper content. The dressing plant is on the seaward side of Mount Besshi, and has a capacity of 1,000 tons a day.

Lest the mine water, charged with sulphuric acid, sulphate of copper and iron, and other ingredients, should damage the farms in the neighborhood, it is treated in cementation plants and then run direct to the sea by a drain, 10 miles long and 1½ ft. square. A large tower-system cementation plant is now being built.

Metallurgical Treatment

The sorted ores are sent down to Niihama, where the main office for the mine stands, by aërial tramway and light railway. Between Niihama and Shisakajima island (9½ miles) a fleet of ore boats ply daily, carrying an aggregate of 400,000 long tons of ore in a year. On the island is a modern smelter, and a process of pyritic smelting is in use. Fine ore and flue dust are first pot-roasted. As the smelter is on an island more than 9 miles distant from any farms, the fumes do not interfere with vegetation. The matte from the blast furnaces is converted into crude copper by Bessemer converters and "Atebuki," an improvement of the old "Mabuki" process. The refined copper is molded into ingots known as the "K. S. Ingot of Japan."

The motive power for the mining operations is derived from a 3,000-kw. hydro-electric plant. The water is led from Hiura, on the eastern side of Mount Besshi, through an adit into the mine and along the third adit to Tonaru and then to Ishigasanjo, on the opposite side of the mountain. The fall is 1,969 ft., with a volume of about 25 cu.ft. per second. The power for metallurgical operations is generated by steam.

For ore and provision transport between Niihama and Tonaru there is a light railway 6 miles long running from Niihama to Hateba and an aërial tramway 12,276 ft. long which connects Tonaru and Kuroishi. For ore conveyance to Shisakajima, there is one tugboat and twenty-four sailing vessels plying daily. For copper ingots, passengers, and general freight, the firm owns and operates three steamers in daily service between Osaka and Niihama, touching at Kobe, Onomichi, and other places. For communicating among the many offices, a private telephone system with 247 phones is provided.

Among the accessory enterprises in which the Sumitomo Besshi mining office is engaged, mention may be made of the manufacture of coke used by the Shisakajima smelter and other works of the firm. Besides, the company has mechanical shops for making and repairing mining tools. Meteorological stations are erected at all places of importance. Forestry goes hand in hand with the mining industry, and the Sumitomo is pushing this work with vigor in the mining districts. It owns 30,000 acres and holds 50,000 acres on lease from the government for this purpose.

Welfare of Employees

There are about 5,200 men on the payroll—3,700 men in the mining department and 1,500 in the metallurgical. The promotion of their welfare has long been the care of the executives of the firm. At Niihama, a hospital has been established, with branches at Tonaru, Shisakajima, and two other places and medical aid provided free in case of accidents. Free primary schools are maintained for the children of all employees. Amusements and recreation are provided; theatrical and other entertainments are given from time to time. Houses are built and let to employees at a moderate rent. Daily necessaries are supplied at a very cheap price by the stores conducted under the firm's supervision. In other words, the entire industry is thoroughly modern.

Home-Made Hot Plate

To make a hot plate, a small box (according to the size wanted) is made of ¾-in. boards, according to Creighton O. Waldorf in the *Chemist Analyst*. It is best not to have the box over 3½ or 4 in. deep. Two porcelain cores should be procured. They should be of the size to come about ½ in. from the top of the box when screwed to its floor. The inside of the box should be lined with asbestos and then a layer of tin. In addition to this the floor should have a layer of fiber or other non-conductor. The cores should now be wrapped with German silver wire. One end of the wire of each core should be attached to a copper strip and the whole fastened to the bottom of the box. The other end of the wire of each core should be fastened to a drop cord. A cover should be constructed of stove tin and the edges bent down so as to fit the top of the box. When this is attached to an ordinary lighting circuit, it is surprising how quickly it heats up.

Platinum in 1922

During the first nine months of 1922 the imports of crude and unmanufactured platinum amounted to 72,410 oz., which is nearly 11,000 oz. more than the imports during 1921. Colombia supplied about half the crude platinum that reached the United States, and some Russian platinum came in through England and other countries. As the domestic supply of platinum and related metals is now almost completely dependent on imports, it is reasonable to expect a considerable increase in the quantity of new metals recovered by refiners. Stocks of platinum at the beginning of the year were about normal, amounting to 64,547 oz. It would seem that as the jewelers had a better year in 1922 than in 1921 the recovery of secondary metals may reach at least 50,000 oz. James M. Hill, of the U. S. Geological Survey, therefore estimates that about 200,000 oz. of platinum was available for consumption in 1922.

Two Electrolytic Copper Processes Compared

Use of Diaphragms and Carbon Anodes Obviates Troubles From Ferric Salts, Is More Efficient, and Is Adapted to Non-oxidized Ores — Non-diaphragm Process Now Employed May Be Modified When Mixed Ores Are Treated

By Anson G. Betts
Inventor of the Betts Electrolytic Lead Refining Process

THE PRECIPITATION of copper from its solution by electrolytic methods may be carried on in two distinct ways, each different in its essential characteristics from the electrolytic copper-refining process, which has no interest in connection with ore treatment and which it is not important to consider in the present connection. The older of these two distinct processes, which might perhaps be called the Siemens process, or the diaphragm process, using sulphate solutions, (leaving out of consideration the use of chloride solutions) depends on the electrolysis of solutions containing iron and copper sulphates with any cathodes adapted to receive a deposit of electrolytic copper, a thin sheet of electrolytically formed copper being cheap and suitable. Insoluble anodes are used, which should be, so far as known, of carbon, or, better, of graphite. The effect of the electric current in this process is to deposit copper at the cathode, at very high efficiency, and to completely oxidize the iron present in the solution as ferrous sulphate, at the anode. If this electrolysis is attempted in an ordinary tank without means of keeping the ferric sulphate formed at the anodes away from the cathodes, no useful result is secured, because the ferric sulphate has a strong dissolving action on metallic copper, being thereby again reduced to ferrous sulphate, nullifying the electrolytic action. It is also not so easy to get reguline, clean, and solid cathode copper, day in and day out, from solutions containing ferric sulphate. Probably ferric sulphate is a solvent for silver and other elements, and its action is to carry and maintain small amounts of them in solution. It is widely known that exceedingly small amounts of impurities in metal-depositing solutions have an entirely disproportionate effect in making cathode metal spongy, rough, incoherent, and branching.

Essential Features of Diaphragm Process

This diaphragm, or Siemens process, to be successful so far as the electrolytic operation is concerned, necessitates, among other important things, a system of diaphragms, or porous partitions between the anodes and cathodes, to prevent intermingling of the anolyte and catholyte—that is, the portions of the electrolyte near the anodes and cathodes respectively, with proper and suitable interconnecting channels or passageways for the two different liquids. As a substitute for diaphragms, certain arrangements have been tried, in which the heavier anolyte, sinking near the anodes, is separately collected at the bottom of th cell and passed thence to the overflow, it being a feature of this type of cell that the feed solution is first treated as catholyte and partly robbed of its copper and then transferred continuously to the anode compartments, where the iron is oxidized and thence discharged. My extensive experiments on this process, however, have shown no encouragement whatever in this direction, when sulphate solutions are used, though there are possibilities with chlorides. The diaphragms become wetted and permit the electric current to pass readily, but practically stop all movement of liquids. In the operation of the cells, the catholyte stands an inch or so higher than the anolyte and there is some passage of catholyte to the anode compartments, but not in sufficient amount to maintain the passage of liquor through the cells, so that leaks or overflows are provided to take care of this automatically.

Practicable Diaphragms Not Unobtainable

The diaphragms used in many or practically all amateur experiments have failed because unsuitable materials have been used; for instance, the old "porous cup" of the chemical supply houses. These firms have not actually carried anything that an experimenter could order and use with any hope of successfully applying it on a large scale, so that there is a general impression that there are no practicable diaphragm materials, which conclusion is not correct. I have patented[1] a useful diaphragm for such purposes, which is nothing more than a somewhat flexible thick sheet of asbestos known as "millboard," which has been made to absorb a small amount of melted sulphur. The sulphur keeps the asbestos from deforming when wet, holding the millboard just as stiff when wet as when dry, and yet the millboard does not contain enough sulphur actually to fill the pores. The only effect is a slight expansion which may be noted after some days. There are probably other practicable diaphragms known and used in electrochemical plants. There are also tile materials and assemblies to provide surfaces large enough for an electrolytic plant, but these are comparatively expensive.

Another consideration in the diaphragm-process cell is the use of a suitable carbon anode. Under commercial current densities of, say, 10 amperes and over per square foot, the electric oxidation at the anode is faulty, the cell becomes polarized, the voltage goes up considerably, the oxidation of the iron drops off, gassing takes place, and the anodes go to pieces. This is caused by a deficiency of iron molecules or atoms at the carbon surface and the tendency of the current to drive them away. However, I have succeeded, in extended experiments, in using both carbon and graphite anodes by greatly increasing the contact of the anode and the iron atoms by giving the anode rods a gentle, continuous, back-and-forth movement.[2] This was effective, easily applied, took only a small amount of power, and gave an effect equivalent to a large circulation of solution. The anode rods were cast in lead in small channel irons with holes for each rod. These

[1] U. S. Patent No. 929,276, July 27, 1909.
[2] U. S. Patent No. 803,543, Nov. 7, 1905, now expired.

channels were assembled on a frame over the tank, mounted on rollers, and given about sixty oscillations per minute, with an amplitude of about an inch, b means of an eccentric. With this device the complete oxidation of the ferrous sulphate to ferric sulphate proceeds smoothly without polarization or raising of voltage, and no destruction of the anodes is noticeable. If the anodes came to rest, the voltage rose in a few minutes, gassing started, oxidization of iron stopped, and the destruction of the anodes began. The device was entirely satisfactory.

Proper Proportioning of Iron and Copper Salts Important

A third consideration of the diaphragm process is a proper balance of the amounts of iron and copper salts in the solutions. Not using heated solutions, it is best to use liquids with about 5 to 7 per cent of iron and copper and several per cent of sulphuric acid besides. If the solutions are much stronger they will crystallize and so give a great deal of trouble. As one ampere deposits 1.19 gm. of copper per hour, and oxidizes 2.09 gm. of iron per hour, at first thought it would seem that the solution should contain about twice as much iron as copper. It does not work out exactly in that way, however, as when, in electrolyzing, copper becomes reduced to much below 1 per cent, the operation becomes delicate and untrustworthy in practice and it is better to avoid this by leaving about 1 per cent of copper in the solution. For a similar reason, the discharge liquor may best contain 1 per cent of iron as ferrous sulphate, and unoxidized, so that the solution should contain about 3 to 4 per cent of iron and 2 to 3 per cent of copper when passed to the cells. The solutions may be somewhat stronger when they are not allowed to become cool.

The operation of such a cell gives 100 per cent efficiency, requires from 1 to 1¼ volts, and gives a yield of copper of around 2 lb. per kw.-hr., which is twice as much as may be obtained by the other process under good conditions.

The diaphragm process is a splendid and almost ideal one from the standpoint of leaching certain classes of copper-bearing materials, such as tailings from a native-copper concentrator. The ferric sulphate is a ready solvent for metallic copper and simple copper sulphides, but is too slow to consider for chalcopyrite. The chemical action that takes place when the cell solution acts on metallic copper and copper sulphides is exactly the opposite of what takes place in the cell—copper is dissolved and iron sulphate reduced to ferrous sulphate. The electric energy absorbed in the cell is liberated effectively in the leaching tank; the solution picks up the copper in the leaching tank, carries it off, and leaves it in the cell as cathode copper. With simple copper sulphides the action is the same, only the sulphur is not attacked and is left behind as elemental sulphur. There is theoretically no limit to the number of times the same solution may be used over again, in this process.

Features of the Non-Diaphragm Process

The other process, the non-diaphragm process, was probably first used as an adjunct in electrolytic copper refining, and in some respects is the same process that is used in making an electrolytic copper assay. In the copper-refinery electrolyte there is a slight and gradual increase of copper sulphate with diminishing free sulphuric acid, and it was desired to correct this in a simple way. It was early found that an easy method was to treat a small amount of the solution in special tanks with lead anodes; this gave a copper deposit on the cathodes and liberated a corresponding amount of sulphuric acid from the copper sulphate.

Features of this process as applied in ore leaching are the use of insoluble anodes of lead or ferrosilicon. Lead anodes are satisfactory as a rule, but will not endure if the liquors contain chlorides or nitrates: ferrosilicon may then be substituted. With a relatively pure solution of copper sulphate with little or no iron present in the solution, the process works smoothly and nicely, with a high current efficiency, at approximately 2 volts per cell, and the whole process and cell is perfectly simple.

In ordinary work on ore, this process meets with a great difficulty from the presence of iron salts, which are beneficial and necessary in the diaphragm process. With most ores, large amounts of iron in the solution can hardly be avoided, and as the diaphragm process uses only half the power, or less, it would seem that it would be more attractive, except on the score of simplicity of cells. In the non-diaphragm cell, the lead anode is a much less efficient oxidizer than the carbon in the diaphragm process. It would not be suitable in the simplest form of the diaphragm process on that account. Neither does it really suit the non-diaphragm process, because it will and does oxidize a good deal of iron. Ferric sulphate, the product of such oxidation, is very unwelcome in this cell, as it redissolves copper from the cathodes and cuts down the electric efficiency and increases the operating difficulties.

The idea seems to be to run the electrolyte through the cells rapidly, extract a small amount of the copper, and get the solution out of the cells again before the ferric iron percentage has reached a sufficiently high figure to nullify the electrolytic action of the current. This relieves the cell to a degree, but places a load on the leaching department, owing to the circulation of large amounts of solution over ore and back through the cells, with a relatively small copper-transferrence efficiency.

Theoretically in this process, in the electrolytic cell, copper sulphate is decomposed into copper and sulphuric acid, and the sulphuric acid is then applied to ore containing cupric oxide, carbonate, and silicate, to make more copper sulphate. In practice it is, from a chemical standpoint, a complicated process.

The Field of Application of Each Process

The diaphragm process would work ideally on ores containing metallic copper and simple sulphides, and the non-diaphragm process would work perfectly on ores containing cupric oxide, copper carbonate, and copper silicate, without iron, because the acid would dissolve the copper and operating difficulties created by the presence of iron would be obviated. The diaphragm process in general is indicated in non-oxidized ores and the non-diaphragm process for oxidized ores. The development of electrolytic treatment of oxidized ores on a large scale has been perhaps in accord with this principle, the oxidized ores having come first into consideration with the companies that have adopted electrolytic methods of recovery.

For the treatment of ores containing both sulphide and oxide minerals, the processes might be made to supplement each other. For instance, if lead anodes were used in a diaphragm cell, the current efficiency would be high, the percentage of copper removed from the solution for each pass would be quite high, and still, in the anode compartments, there would be some formation of ferric salts, enough for an ore largely but not entirely oxidized. Another and probably better system for the treatment of partly oxidized ores would be to use the diaphragm process, apply the ferric-sulphate solution to the ores, when all soluble copper minerals would dissolve, the oxides dissolving on account of the free acid present, and the sulphides, metallic copper, and cuprous oxide, being attacked and dissolved by the ferric sulphate. After the leaching the solution would still contain some ferric sulphate, and this could then be reduced with sulphur dioxide, so that the solution passing to the cells could be practically free from ferric iron. At the same time the sulphur dioxide, by being converted into sulphuric acid, or sulphuric-acid intermediates, would build up the solution in acid, so that portions of the electrolyte could be bled off continually, thus serving for purification and control of iron content and making up for the loss of acid being discharged as iron sulphates.

All electrolytic copper processes, in one particular, appear to possess one disadvantage in comparison with the cyanide process wherein a solvent solution is applied to the ore and the solution is then made to yield the great bulk of the gold. In the electrolytic copper processes, the cells will not extract a very large percentage of the copper advantageously, and it is therefore necessary to keep a lot of copper sulphate in circulation, from ore to cells and from cells to ore. This is a disadvantage in some respects, although by no means sufficiently so as to render the process entirely inapplicable in the connection noted.

It may justly be said that the accomplishments up to the present in electrolytic recovery of copper from ore are due largely to financial and engineering skill rather than to development and application of electrochemical progress. In consequence there is mu room for improvement in the chemical and electrc chemical features.

Metallurgical Practice in the Porcupine Gold District

In one point there is uniformity in milling practice in the three large plants of Porcupine, says J. C. Murray in the *Canadian Mining Journal*. Precipitation of gold from cyanide solution is effected in all three plants with zinc dust. At the McIntyre mill, zinc boxes were given a trial and were quickly abandoned. In all three mills lead acetate is used to aid precipitation.

There is wide divergence in refining methods at the three plants. At the Hollinger, the raw precipitate is smelted in blast furnaces; the bullion is brought down with lead; the lead is driven off in standard cupellation furnaces, and a bullion of 950 total fineness is obtained. At the McIntyre the raw precipitate is treated with sulphuric acid and melted in a carborundum-lined, tilting, reverberatory furnace. The bullion here is brought to a total fineness of 900. The practice at the Dome consists in treating the precipitate with sulphuric acid, calcining, and melting in small clay-lined graphite pots in a reverberatory furnace. The fineness obtained is from 990 to 995.

It is likely that the roar of the stamps, will soon be a forgotten sound in Porcupine. The stamp is an illogical and power-wasting contrivance at best. It is a strange and anomalous survival. In the last ten years it has lost much face. Experience at Porcupine has contributed not a little to the stamp's approaching relegation to oblivion.

Regarding Porcupine milling practice, some incidental changes in the flow sheets are extraordinarily interesting. For instance, the use of Hudson Bay blankets on the lower ends of amalgamating plates at the Dome mill was a distinct improvement. In due time these costly items were superseded by a cheaper and more suitable material, wide strips of "silent felt" the stuff in common use between the linen tablecloth of civilization and the mahogany table.

Another instance is afforded by the supersession of pebble grinding at the McIntyre by the use of steel slugs. A slight increase in cost was compensated for by greater tonnage and a much more uniform product.

Another change in practice at the McIntyre resulted in reducing the consumption of zinc from 0.20 lb. per ton of solution to 0.05 lb. per ton of solution.

Mine Telephoning by Radio

The use of radio telephone instruments has now become so general that inquiries have been made as to the feasibility of the use of radio instruments underground, with the idea advanced that they would be especially valuable when accident interfered with the ordinary means of communication. The U. S. Bureau of Mines has investigated the matter at the Bureau experimental mine at Bruceton, Pa., in co-operation with radio engineers from the Westinghouse Electric & Manufacturing Co. The experiments are described in *Reports of Investigations* No. 2,407.

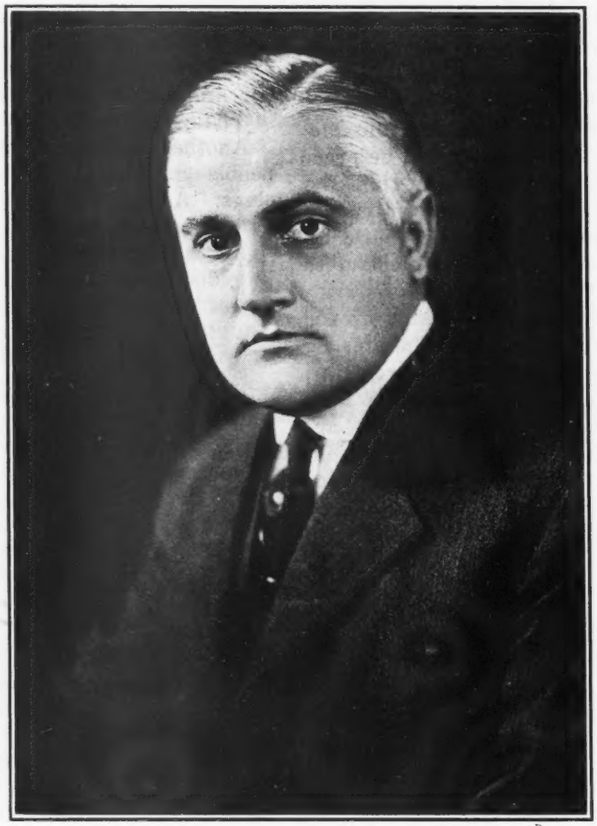
The experiments consisted first in receiving signals from without the mine by means of a receiver located inside the mine, and, second, both sending and receiving messages underground through the strata. It was found that with a receiving instrument set at a point 100 ft. underground, signals from KDKA station of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., could be heard distinctly. Station KDKA is at a distance of about 18 miles from the experimental mine. About 50 ft. from the receiving station used in this test was a 6-in. bore hole from the surface, lined with iron pipe and containing electric-light wires which extended therefrom throughout the mine. The presence of these wires evidently assisted greatly in the reception, for when the receiving set was carried to another point in the mine removed from wires and tracks the signals were barely audible through 50 ft. of cover. The fact that signals were detected, however, even though faintly, is sufficient evidence of transmission through the ground to encourage experimenting.

The preliminary experiments, although unsuccessful in indicating any practical method of using wireless waves for underground communication, nevertheless indicate clearly that electromagnetic waves may be made to travel through solid strata. The "absorption" or loss of intensity with distance is very great for the short wave lengths (200 to 360 meters) used in these experiments. Longer wave lengths are known to undergo less absorption and may possibly be found practically effective under certain conditions.

Mining Engineers of Note

LOUIS SHATTUCK CATES

THE STUDY of the human voice as a guide to character is not a developed science, so far as the writer of this sketch is aware. Perhaps possibilities in this direction have been overlooked. We suspect, for instance, that yon Cassius was endowed with a lean and hungry voice, although we have never seen the fact recorded. These observations are evoked by the recollection that some years ago we had occasion to make the close acquaintance of a really remarkable voice ten minutes before we saw the owner of it, or even learned who he was. During the interval we studied the voice. It was full but not loud; deep but not guttural. It sounded authoritative but not overbearing; confident but not blustering. It was extremely friendly without any suggestion of the political "glad hand." It was sympathetic and it was sincere. We felt that if the voice were angry we should prefer to have it directed toward somebody other than ourself, yet the dominant impression, except for that of bigness, was one of good will and humanness. It was the kind of voice that we should think would make a blind man feel that the world was not such a bad place after all. This is a good deal to say about a voice, but you must remember that this was an extremely unusual voice. We have felt free to be complimentary because the description of the voice is the result of personal experience; we can add that those who know the possessor of the voice best say, very earnestly, things that lead to the conclusion that in this case at least the voice is a very accurate index to the character of the man. Quite as convincing as the testimony of his associates at the top of the industrial ladder is that of one Jerry Williams, a "chute drawer" who once worked in the old Boston Con. mine in Bingham and then went to the Ray Con. to work under his old boss, the owner of the voice. He, as you may suspect, was Louis Shattuck Cates, now general manager for the Utah Copper Co., a project in which more earth will be handled than was moved in the digging of the Panama Canal. Mr. Cates is also consulting engineer of the Ray Consolidated Copper Co., president of two mining-town banks, and director of a dozen assorted corporations. Sometime ago Mr. Spurr asked a number of mine executives to give their views as to the effects of prohibition on the mining industry. Mr. Cates probably did not know that his answer was to be used as evidence against him, but here is part of his letter: " . . . Employees have better furniture, more of the comforts of home, and take far better care of their wives and children . . . In one camp prior to prohibition, 90 per cent of the children were barefoot and very few houses were equipped with electric light and telephones. Now the children are well kept; practically all of the houses have electric lights; over 120 telephones have been installed, and the whole general tone and aspect of the camp is tremendously improved . . . I do not wish you to get me wrong in the sentiments here expressed by believing that I am a teetotaler and a former prohibitionist. I voted against prohibition, but since it is with us I am frank to say that if it were on the ballot this fall I would certainly vote for it." Whether you are an advocate or an opponent of prohibition you can read character in these words.



LOUIS SHATTUCK CATES

Mr. Cates was born in Boston, Mass., on Dec. 20, 1881, and after the usual vicissitudes attendant upon growing up in that attenuated atmosphere, graduated from M. I. T. in 1902. After a brief sojourn in Parral, Old Mexico, he went to Bingham, Utah, for the Boston Consolidated, becoming general manager in 1909. When the Utah Copper Co. acquired the Boston Con., Mr. Cates was sent to Ray, in Arizona, where he developed the "Ray" system of shrinkage stopping and block caving. In 1919 he went back to Utah as assistant manager for the Utah Copper Co., and on June 1, 1922, he was made general manager. In the letter giving these bare facts, Mr. Cates rather apologetically regrets that he was unable "to figure out anything sensational in my short career," to which we may venture to reply in the words of the squirrel,

> "All sorts of things and weather
> Must be taken in together
> To make up a year and a sphere!"

CONSULTATION

More Silver Currency and Circulation Details

"Your answer to my recent letter[1] of inquiry in regard to English coinage is exactly what I desired. You seem so liberal in your desire to inform me further that I am taking the liberty of asking you some further questions.

"Is the British currency of reduced fineness used wholly at home or is some of it used in trade with other nations and passed, as, for instance, on the United States of America, as of equal value to our coins?

"Is not this move by England the prime cause of the decline of silver on the foreign market since some time in 1920?

"Is the silver that is used by England in India coined in England, or is it shipped in bullion form to India and coined there? If coined in India, is that coinage of the same fineness as in England? I ask this question as I am informed that England uses a large amount of silver in India.

"If you feel that it is going to work a hardship on you to furnish these details I will not feel in the least hurt should you cut it out and not try to answer, but if you can give me these data without too much trouble I certainly would appreciate it, as this silver question is a very vital one to me as a silver miner, as it is to all silver producers, and I cannot help but wonder sometimes if the silver producer is getting an absolutely square deal."

The British currency of reduced fineness circulates in Great Britain and those colonies, such as Australia and South Africa, which have adhered to the use of the currency system of the mother country. Canada, the Straits Settlements, India, and other colonies have currency systems that are based on units different from those established by the parent country, and hence the silver coinage of these colonies is not interchangeable piece by piece with that of England. Furthermore, as the settlement of business transactions between nations is ordinarily finally balanced by shipments of gold (China and India are exceptions), silver coinage plays no part in the trade of European and American nations among themselves, but silver occupies a prominent financial position in the conclusion of business transactions with the Far East. The only instance of which we are aware near at home where American and foreign coins circulate as having equal value is along the Canadian border. But the small reduction in the fineness of Canadian subsidiary coinage has tended to affect this condition, for Canadian silver coins are worth less in bullion value than those that are minted by the United States.

In answer to the second question, the decline in the price of foreign silver in 1920 cannot be entirely attributed to the action of the British Government in debasing its silver coinage. It was a contributing cause, undoubtedly, but there is no warrant for assuming that it was a governing one.

[1]See issue of Dec. 30, 1922.

In answer to the third question, the silver that is used in India's currency is coined by the local Indian administration at the Bombay and Calcutta mints. The silver metal from which the coins are stamped is shipped generally in bullion form from many corners of the globe. However, England executes the coinage requirements of many of its smaller colonies and protectorates. Thus it is interesting to observe that in 1921 the Royal Mint in London coined fourpence pieces for British Guiana, piasters of various denominations for the island of Cyprus, silver florins for East Africa, piasters for Egypt and Indo-China, and silver fanams for Travancore (the fanam is a small coin circulating in the southern part of India). The silver rupee which is the standard coin of India did not have its fineness altered at the time when the shilling was debased. The fineness of the rupee remains at 916⅔, which is relatively much higher than that of Great Britain's silver coins. India, however, in 1920 changed the ratio of rupees to the pound sterling from 15 to 10. In other words, by official proclamation the value of the rupee in dollars and cents was officially raised from 32.4c. to 48.7c. India consumes large amounts of silver annually and with China is the main support of the world market. Conditions in the Far East are of extreme importance to the silver mines and the property of the producers throughout the world.

United States Mining Lands Not Open to Canadians

"Will you advise me if it is lawful for a Canadian citizen to take up mining claims in the United States in his own name? The location notices show for 'citizen of the United States, or those who have declared their intention to become a citizen,' but I am informed here that there was an understanding between Canada and the United States permitting citizens of either country to locate claims in the other country. I would greatly appreciate your letting me know the exact status of the Canadian citizen in prospecting in the United States."

The United States mining statutes provide that only citizens of the United States and those who have declared their intention to become such are permitted to make locations on mining lands in the United States. This would seem to prohibit Canadians from taking up mining claims in their own names. This statement is confirmed by advices we received in substantiation of this point.

The Oil Leasing Act, passed Feb. 25, 1920, for the leasing of oil, gas, coal, and other minerals, provides that citizens of another country, the laws, customs and regulations of which deny similar or like privileges to citizens or corporations of this country, shall not by stock ownership, stockholding, or stock control own any interest in any lease acquired after the provisions of this act. It might have been this reciprocal provision which prompted the above inquiry.

THE PETROLEUM INDUSTRY

Standardization of Tool Joints*

BY S. A. GUIBERSON, JR.
President, The Guiberson Corporation

IN REGARD to standard tools, this Institute at its last meeting authorized the late Louis C. Sands, then director of the Supply Company Division, to call a meeting of the manufacturers of cable tools in order to ascertain whether the standardization of cable tool joints could not be effected. On June 21 of this year such a meeting was called in Pittsburgh, at which certain standards for threads on pin and box were agreed upon and a committee of seven members was appointed to go further into this subject.

The greatest step of all, however, was recently taken when the standardization committee of the Mid-Continent Oil & Gas Association met in Tulsa on Nov. 14 of this year with leading operators, their engineers, and representatives of manufacturers of tubular goods and there agreed on certain standard sizes for oil well casing. The adoption by oil operators, as a whole, of the standards agreed upon at that meeting would be the greatest single advance that could possibly be made toward standardization of oil well equipment, because the sizes of casing used in drilling wells determine in large measure the sizes of tools and other equipment used in connection therewith. Especially is this true as regards tool joints, since the inside diameter of casing, in all sizes up to 10 in., is the factor which determines the size of a tool joint, either cable or rotary.

FACTORS AFFECTING CABLE TOOL STANDARDIZATION

The cable tool joint is and always has been the weakest part of a string of tools. Its dimensions have been limited by the diameter of the casing in which it is to be used. (I am speaking now of casing 10 in. or less in diameter.) Therefore a different size string of tools is commonly used inside each different size of casing under 10 in. in diameter. It is perfectly possible to drill a well with cable tools to a depth of 5,000 ft. or more with the use of only three strings of tools (except bits), one for 8-in. and larger casing, one for 6¼-in. and 6⅝-in. casing and one for 4½-in. or 4¾-in. casing. Instead of three, we find listed in manufacturers' catalogs some twelve different sizes of tools for western specifications and eleven different sizes for eastern specifications, each size being determined by the tool joint it carries. For each size of tools and casing the operator must carry a stock of wrenches, fishing tools, elevators, underreamers and extras of various sorts. A survey of the tool platform of any property, even of moderate size, is staggering, while the tool equipment at the central camp of some of our larger companies passes the comprehension of all except those who paid for them.

Adoption of the new sizes of casing recommended by the Mid-Continent Oil & Gas Association will greatly simplify the problem after the new standards come into general use. The 9¾, 7⅛ in. and 5 in. inside dimensions recommended will determine the three sizes of cable tools it will be necessary to manufacture. If the new casing standards are adopted it is not unreasonable to expect their acceptance by operators as quickly as is economically possible and the development and adoption of standard tools should proceed simultaneously.

There have been issued over 200 patents covering improvements in cable tool joints as well as nearly 100 covering improvements in rotary tool joints and yet nothing has replaced the coarse-threaded, steep-tapered joint, with a shoulder, that is now in use. It has been used for forty years without change, and it is not probable that any drastic change in form of joint is imminent. Rather, standardization will proceed along the lines of elimination of unnecessary sizes and the exchange of templates so that tools of all manufacturers will be interchangeable.

ROTARY TOOL JOINT PATENTED

Since there is a committee now working on the standardization of cable tool joints, I will not go further into the various phases affecting same, for without doubt that committee will thoroughly cover the subject. The rotary tool joint, however, presents some phases peculiar to itself, and while already much has been done toward standardization of this tool, there is more to be accomplished, and from the experience so far encountered in attempts that have been made, I can see difficulties ahead before complete success is had.

As is commonly known, the rotary tool joint so universally used is covered by United States letters patent and therefore is subject to more or less control in construction. Had there been, when this tool was first used and patented, full realization of the tremendous future growth of the rotary method of drilling, and of the universal adoption of the rotary tool joint as standard equipment on rotary drill stems, and of the practical impossibility of drilling our deep wells without the use of rotary tool joints, proper steps would have been taken to develop certain standard dimensions, and licensed manufacturers would have been requested to adhere rigidly to these standards. Before it was fully realized that the joint was patented, numerous manufacturers began turning them out, adopting standards of their own ideas, according to their individual ideas.

When control of the patent was turned over to me, tool joints had already been in use for two years and were being manufactured by several concerns. The first step taken was the preparation of detail drawings of standard sizes for 4 in. and 6 in. joints, the only two sizes then used. Blueprints of these drawings were furnished all licensed manufacturers and most of them adhered to the dimensions shown. The 6-in. rotary tool joints were early standardized at 7¾ in. outside diameter, seven threads per inch, 5 x 6-in. box and pin, and these specifications have remained the same with the exception of the thread, which in 1915 was changed from seven threads per inch to four threads per inch. Since

*Excerpted from a paper presented at the annual meeting of the American Petroleum Institute at St. Louis, Mo., Dec. 6-8.

that date the 6-in. tool joint has been uniform, the only variation being that which each manufacturer might make in his master gage. This has usually been sufficient to prevent the joints of one manufacturer from interchanging with those of another.

The 4-in. joint was copied as closely as possible from cable tool joints and was at first made with a 3½ x 4½-in. box and pin, seven threads per inch, 5¾ in. outside diameter. It was not long, however, until various operators began to call for a change in one dimension or another. Some manufacturers preferred to make slight changes in their standards so that by no possibility could their joints be used interchangeably with those of another manufacturer. Coarser threads were found desirable in small joints as well as 6-in. joints. Mid-Continent operators wanted a 4-in. tool joint which could be used inside of 6-in. casing and consequently the outside diameter was changed from 5¾ to 5⅞ in., much to the disgust of tong manufacturers, as well as tong users. The result was that in very few years there developed a wide variation in standards for rotary tool joints for 4-in. drill stems and smaller.

A serious attempt was made two years ago to get all rotary tool joint manufacturers to agree on a definite set of standards, with the hope that these standards would be universally adopted, not, of course, immediately, but gradually, as old stocks in possession of operators were worn out and discarded. All manufacturers believed that such a goal was desirable and agreed to do their best to adopt it if there could be obtained a concurrence of opinion as to what standards were the best. Recommendations of various manufacturers did not agree in many instances and it was quite clear that the co-operation of operators must be obtained before the desired end could be accomplished. Certain improvements were made, however, and much headway was made in uniformity of outside diameters. Furthermore manufacturers began exchanging templates in many instances and it is now possible to get rotary tool joints from any of the large manufacturers which will interchange with those specified by the operator. The adoption of standard sizes of casing will assist in making uniform the outside diameter of all tool joints.

The points so far brought out cover only the pin and box end of the tool joint and its diameter. Another vital part of a rotary tool joint is the pipe thread end and in this we find a wide variation due to the fact that threads on various makes of drill stem are not interchangeable. It is well known that, though all regular casings and drill stems are usually made to the same thread specifications, tubular goods manufacturers employ different methods for gaging threads, and frequently collars from one make of casing will not fit the thread on another make. Then we find seamless tubing drill stem, interior upset drill stem, and recently a large tubular goods manufacturer brought out a drill stem with a change in thread that will necessitate a change in the pipe thread of every tool joint now manufactured before it can be used on this drill stem. The pipe end of a rotary tool joint must fit the drill stem on which it is to be used and therefore standardization of this end must necessarily await that of the drill stem and on this point operators and manufacturers must also agree.

Vast improvement in the life of rotary tool joints has been made by successful heat-treating. Further study and research along the line of material and heat-treating will undoubtedly yield much benefit, and on this point exchange of data will be of material assistance toward standardization.

The rotary tool joint when made out of a quality of steel best suited for its particular use, by the most skilled machinist with the best equipment, and then heat-treated and tempered properly will last and safely do the work for which it is intended for a number of years. Several strings of rotary tool joints are in use that have drilled over 30,000 ft. of hole and they are still in good condition, while other rotary tool joints are worn out and unsafe to use after drilling five or six thousand feet of hole. This is not fair to the operator and there is really no excuse for this condition to continue. It is, however, not a guessing proposition. It is one to be carefully studied and worked out by competent engineers having full access to all the data and conditions under which these rotary tool joints are used. It is not enough that the rotary tool joint be standardized as to outside diameter and size and taper of thread. The quality of material, heat-treatment, temper and workmanship are as vitally important in their necessity for standardization.

Recommendation as to Standardization

When one considers that, as with cable tools, there are only three drill stems necessary to drill a rotary well to any depth required, it would seem to be an easy matter to reach an agreement on these three sizes, namely: 6 in., 4 in. and 3 in.

There is no justification in my opinion for western, Mid-Continent and eastern standards for tool joints, and efforts should be made to eliminate such different standards. To carry out the standardization work properly, a committee should be appointed by this Institute, consisting of representatives of the large manufacturers and of the operators. In selecting the members representing the operators, due regard to localities where different standards and methods of drilling are in use should be taken.

Special attention should also be given in the selection of this committee to the fact that its work is largely technical and scientific; what the operators want today is a standard based on quality, manner of construction, heat-treatment, size and taper of thread that will give best results and come the nearest to eliminating the present faults. Such a committee should agree on the fewest sizes of tool joints required to properly drill a well to 5,000 ft. or deeper and on the specifications for each size agreed upon. These sizes should be listed as "standard sizes"—any other sizes should be listed and known as "special sizes." They should also go fully into quality of steel, heat-treatment and temper best suited for this work. Should they arrive at such an agreement, then master gages should be made up covering each standard size and arrangements made to supply manufacturers with templates from these master gages, with finger pieces and full directions for turning out tool joints that would be interchangeable in every respect.

Some provision would have to be made for rechecking these templates from time to time to prevent gradual departure from the standard, due to wear of templates. This committee should then prepare detailed report setting forth reasons for adoption of the standards agreed upon, making same as conclusive as possible for such adoption. With such a report before them, the operators would demand this standard, and manufacturers would readily adopt same.

New Books

A Petroleum Library in Two Volumes

Handbook of the Petroleum Industry. Two volumes. David T. Day, editor-in-chief. John Wiley & Sons, Inc., New York. $15. Each volume separately $8.

Though the phrase be hackneyed, it is nevertheless true that no petroleum library is complete without this valuable handbook. In fact, it is a petroleum library in itself, including within its cover fifteen separate works on as many subjects and by as many authors. In addition, thirty-seven pages are devoted to petroleum statistics, ten pages to general tables, and six to a brief summary of current petroleum literature. An eighty-three page glossary of the terminology of the petroleum industry completes the work. The handbook is well indexed and amply illustrated with half-tones and line drawings. Many technical handbooks and pocketbooks are so compact and condensed and printed in such fine type that it is difficult to use them save as works of reference, valuable as they may be for this purpose, which they are intended to serve. The new "Day" is easily readable, so that it can be readily used as a textbook. The pages are 7½ x 4½ in. inside the margins and the typographical work is excellent.

The scope and thoroughness of the book are indicated by its contents. Chapter 1 of Vol. I, covering 166 pages, is entitled "The Occurrence of Petroleum," by Frederick G. Clapp. Chapter 2, 34 pages, "Field Methods in Petroleum Geology," by Frederic H. Lahee. Chapter 3, 120 pages, "Oil-field Development and Petroleum Production," by Louis C. Sands. Chapter 4, 37 pages, "Statistics of Petroleum and Natural Gas Production," by Anne B. Coons. Chapter 5, 99 pages, "Transportation of Petroleum Products," by Forrest M. Towle. Chapter 6, 130 pages, "Characteristics of Petroleum," by David T. Day. Chapter 7, 140 pages, "Petroleum Testing Methods," by T. G. Delbridge. Chapter 8, 58 pages, "Natural Gas Gasoline," by H. C. Cooper. Chapter 9, 44 pages, "Asphalt," by R. G. Smith. Chapter 10, 64 pages, "Oil Shale," by David Eliot Day.

In Vol. II, Chapter 1, covering 426 pages, is devoted to refining, and is written by A. D. Smith. Chapter 2, on "Cracking Processes," by Roland B. Day, is 17 pages long. Chapter 3, 77 pages, is entitled "Use of Fuel Oils," by W. N. Best. Chapter 4, 101 pages, "Internal Combustion Petroleum Engines," by Arthur H. Goldingham. Chapter 5, 55 pages, "Lubrication," by John D. Gill. Chapter 6, 77 pages, "Pipe Standards and Use of Pipe," by F. N. Speller. Following come the tables, bibliography, and glossary already referred to. The editor-in-chief and his collaborators are entitled to much credit for their accomplishment. Whoever parts with the purchase price is surely getting his money's worth.

Material Handling

Material Handling and Storing of Material. By George Frederick Zimmer. 3d edition. D. Van Nostrand Co., New York. $15.

This is a revised edition of a well-known English book on this subject whose completeness may be judged from the fact that it contains 800 pages of a somewhat larger size than the ordinary technical book—viz., 7 x 10 instead of 6 x 9. It is well illustrated, and, although the treatment is from the English standpoint, throughout, American designers will find much of value. Extensive data of historical interest on the development of material-handling machinery are given, it being the aim to describe the most up-to-date equipment toward the end of each chapter. Machinery which has not been thoroughly tried out and accepted by responsible engineers is not discussed.

The subjects covered include the continuous handling of material, by elevators and conveyors of various types; the continuous handling of material by pneumatic and hydraulic means; the intermittent handling of material by rope, chain, and cable haulage, and by monorail equipment; unloading and loading appliances; automatic weighing; and various other specialized forms of equipment within the field.

How to Form an Oil Company

Business of Oil Production. By Roswell H. Johnson, L. G. Huntley, and R. E. Somers. John Wiley & Sons, Inc., New York. $4.50.

Recognition of a need on the part of oil company executives and others in the oil industry for a book dealing primarily with the management of petroleum production has led the authors to write this volume. The subject was briefly treated in Johnson and Huntley's "Principles of Oil and Gas Production," which came out in 1916, a revision of which is now to be presented in the form of a series of separate volumes, the book under review being the first of the series. The others, it is promised, will appear from time to time; the second, in particular will deal with the subject of valuation.

Much useful information is presented compactly in the new book. Beginning with an analytical discussion of the various ways of obtaining oil-producing lands, the authors successively take up the topics of classes of holdings, form and provisions of leases, and the technique of leasing. Two chapters are devoted to brief synopses of the legal requirements for obtaining oil and gas rights on federal and state lands and in the foreign countries of North and South America. Trading in leases and royalties and indirect ways of sharing in the profits of oil land development are described. The advantages and efficiency of small and large companies are compared and the matter of organizing and developing personnel receives due attention. An interesting chapter is one discussing the oil company prospectus. In another, data as to cost of drilling and other phases of operation are given, which will be welcome to many. Cost accounting, depreciation, depletion, and taxation are discussed separately. The two chapters devoted to "Drilling Methods" and "Extraction of Gasoline from Gas" are about the only ones that border on the technical. The authors close with an interesting review of the Mexican situation and a forecast of the industry's future. The text of the Oil Land Act of 1920 and other similar matter is given in an appendix. On the whole the book will be found exceedingly useful.

A Chemical Engineering Volume

Transactions of the American Institute of Chemical Engineers. Vol 13, part 2, 1920-21. D. Van Nostrand Co., New York.

This book has several papers of interest to mining and metallurgical engineers. These include: "Recent Advances in the American Sulphur Industry" by Raymond F. Bacon and Harold S. Davis; "The Chemical and Physical Properties of Sulphur"; "Conservation of Heat in Power and Heating Systems"; "The Sulphuric Acid Plant Fume Problem"; "Resources of the State of Louisiana"; and "Some Problems in Non-Ferrous Metallurgy." The last paper mentioned deals with metallography rather than metallurgy.

The 1923 Commercial Directory

Hendrick's Commercial Register of the United States. 1923. S. E. Hendricks Co., New York. Price, with monthly bulletins during the year, $15.

This is a book to which we frequently refer when a subscriber asks us who are the principal users of sheet mica in Illinois, or who makes the Jim Dandy belt lacing. It is a large book—8 x 12 inches, and containing more than 2,300 pages—and is a substantially complete index of the various commodities that are marketed in this country and the names of the people that make them. There is also the usual section alphabetically indexed by trade names, and an alphabetically arranged list of manufacturers with their addresses. A book of particular interest to the selling and purchasing departments.

Approved Blasting Practice

Blasters' Handbook. Compiled by Arthur La Motte. E. I. du Pont de Nemours & Co., Wilmington, Del. Free.

This little book of 154 pages is decidedly worth placing in the hands of everyone having to do with blasting who can read English. Complete directions for all kinds of work are given, and of course the operator need not use the du Pont powder recommended unless he wants to.

SOCIETIES, ADDRESSES, AND REPORTS

Crushed Stone Association Convention Jan. 15-17

Program Includes Numerous Technical Papers—All Phases of Industry Covered

A long program has been provided for the sixth annual convention of the National Crushed Stone Association which is to be held at the La Salle Hotel, Chicago, Ill., Jan. 15-17, 1923. Many papers on merchandising, financing and other phases of the crushed stone business are to be presented. A large number of papers of a technical nature are included. Some of these are:

"Valuation of Stone Deposits, Including Exploration of Quarry Property; Geological Data; Exploitation Possibilities, etc.," by Joel H. Watkins, mining geologist, Leesburg, Va.

"Drilling and Blasting" (illustrated with lantern slides), by J. Barab, engineer, Hercules Powder Co., Wilmington, Del.

"Steam-Shovel Operating Costs," by A. C. Vicary, vice-president of the Erie Steam Shovel Co. This will be the first public announcement of the results of the Erie Steam Shovel Co.'s prize contest on steam-shovel operating records.

"Gasoline Quarry Locomotives," by H. R. Sykes, Fate-Root Heath Co., Plymouth, Ohio.

"The Jaw Crusher as a Primary Breaker," by C. G. Buchanan, president of C. G. Buchanan Co., New York City.

"The Gyratory Crusher as a Primary Breaker," by W. J. Roberts, president, Traylor Engineering & Manufacturing Co., Allentown, Pa.

"Roll Crushers as Primary Breakers; and Secondary Breakers, Screening and Sizing," by Brownell McGrew, engineer, Allis-Chalmers Mfg. Co.

"Washing and Separation of Sizes by Hydraulic Methods," by Edmund Shaw, consulting engineer, Chicago.

"A New Type of Shovel for Crushed Stone Handling," by George E. Deatherage, general manager, the Hoar Shovel Co., Duluth, Minn.

"New Roller Grizzly," by Thomas H. Robins, Jr., Robins Conveying Belt Co., New York City.

"Steel-Belt Conveyors," by Mr. Carlton, engineer, Sandvik Steel, Inc., New York City.

"Electric Storage Battery Locomotives," by C. W. Chappelle, Ironton Engine Co., Ironton, Ohio.

Discussions of such topics as "Stripping Methods and Costs," "Drilling and Blasting," and "Crushing and Screening" are to be held. Dr. Oliver Bowles, of the U. S. Bureau of Mines will preside at the sessions opening on Jan. 16 and will deliver the introductory address. The banquet will be held Jan. 16.

Economic Geologists Meet at Ann Arbor

Results of Calumet & Hecla's Survey Announced—Interesting New Facts Told Regarding Homestake Orebody and Nickel Deposits at Sudbury—Other Papers

THE Society of Economic Geologists held its third annual meeting at Ann Arbor, Mich., from Dec. 27 to Dec. 30, 1922. The meeting was held at Ann Arbor by invitation of the University of Michigan. At the same time there met a number of other geologic and geographic societies, including the Geological Society of America, the Paleontological Society, the Mineralogical Society of America, the Association of American Geographers, the National Council of Geography Teachers, and the Association of State Geologists. The excellent buildings and facilities of the University of Michigan were placed at the disposal of the visitors.

The retiring president, Waldemar Lindgren, delivered his presidential address on Friday, Dec. 29, the subject of his scholarly remarks being the "Concentration and Circulation of the Elements From the Standpoint of Economic Geology." This dealt with the migration of metals, particularly in the sedimentary cycle, and especially through the agency of organisms and organic matter. Helium, he believed, was liberated through the radioactivity of sedimentary rocks; and probably vanadium and uranium were among the elements concentrated in sedimentary rocks sufficiently to form ore deposits. Many other elements, including copper, lead, and zinc, were extracted from sea water or sea muds by special types of organisms.

Friday afternoon was given over to the discussion of the deposits of native copper, and the Geological Society of America was invited to participate. The Calumet & Hecla Mining Co., with a liberal attitude toward science which is most praiseworthy, had permitted its geological corps, headed by Prof. L. C. Graton, of Harvard University, to present the results of the thorough geological investigation which has been going on. The co-authors of the conclusions presented are B. S. Butler, formerly of the U. S. Geological Survey; T. M. Broderick, Charles Palache, Alfred Wandke, and C. D. Hohl. An abridged summary of some of the points in the paper follows:

The copper district of Keweenaw Point, Mich., is the second largest producer in the world, with a total output, since 1845, of nearly seven billion pounds of copper, in large part about equally from conglomerate and amygdaloid lodes and in smaller part from fissures. Nearly all the copper is native; a little occurs as arsenide and as sulphide.

A great succession of basaltic lavas issuing in Keweenawan time from extensive fissures built up a series of flows thousands of feet thick. Here and there interbedded with these flows are thin but commonly extensive layers of felsitic conglomerate.

The basalt flows were highly charged with gases, mainly steam, which were liberated during the progress of flow and which, in part, escaped and in part were imprisoned in the congealing upper portion of the flow to form a vesicular zone, later converted to amygdaloid by filling of the vesicles. . . . The most important of the amygdaloid lodes commercially, however, were produced by a combination of this process of vesiculation with brecciation of the freezing top by movement of the still liquid part below. This produced a top not unlike a conglomerate in general appearance and texture. A third, scoriaceous type of top was produced by explosive escape of contained gases from the surface of the flow, probably because of contact with shallow pools of surface water.

The lava tops generally and the brecciated type in particular are red as compared with the dark trap portions of the same flows. The red color is due to hematite present in minute crystalline flakes through the groundmass of the rock. Chemical analyses show that ferric iron steadily increases in proportion to ferrous from the bottom of the flow to the top, and in the amygdaloidal part of the flow it greatly predominates. In some flows the increase is 40 per cent over the iron content of the lower trap. We believe that the oxidation was not produced by weathering while the traps were exposed, but that oxidation, together with the iron concentration in the tops, was probably the work of gases arising from the deeper parts of the flows before and during solidification of the tops. . . .

Previous observations that the apparently fresh traps contain minute amounts (0.02-0.04 per cent) of copper are confirmed, but the freshest rocks are not absolutely fresh, and they are found to contain particles of native copper and of copper sulphides. We conclude that the greatest part of the copper in the traps is present in these forms, and has been introduced in minute amount into these dense rocks at the same time and by the same solutions that formed the great ore deposits in the more permeable conglomerates, vesicular layers, and major fractures.

It has been impossible to find any adequate source of copper at or near the surface, as, for instance, volumes of rock from which copper has been leached, nor can we imagine any such source that will square with the facts. In general, copper seems to have been added to the rocks, not leached from them.

The alternative conclusion is, as certain earlier workers have proposed, that the solutions and the copper came from a deep-lying magmatic source, connected, we suppose, with the source of the basalts and the Duluth laccolith, but being an accumulated after-effect to the eruption of those rocks. Many facts of occurrence support this conception of source, and none of importance oppose it. All the evidence is in accord with a single but complex period of mineralization. Very striking is the upward limitation of orebodies against and their particular richness near the under side of relatively impermeable barriers, whether formed by the pinching and change in texture of conglomerate as in the Calumet & Hecla, thinning of amygdaloid lode as in the Oseola and other mines, shale covers as at White Pine, or cross faults as shown in several examples. These structural relations are not reasonably explicable except by the conclusion that the ore deposits were formed by ascending solutions when the rocks were in their present attitude.

The mineralogy of the deposits likewise contradicts the idea that they are due to the action of cold surface waters, but it accords with that of their derivation from magmatic mother liquors containing mineralizers like boron, sulphur, and fluorine, and yielding minerals formed only at high temperature, like those characterizing hydrothermal deposits generally—epidote, chlorite, sericite, etc., as well as quartz and calcite. The copper occurs predominantly in rocks that were very low in ferrous iron, but that contained plentiful ferric oxide as hematite. Immediately around the particles and lumps of native copper the red color due to the hematite is bleached, and chemical analysis shows that the material of these bleached aureoles has lost most of its ferric iron and much of its total iron, but that ferrous iron has been either only slightly decreased or even increased. In a word, the rock adjacent to the copper appears to have been attacked by a reducing agent. The idea has been suggested that this margin of bleaching is due to reduction of the hematite by the conversion of the outer rim of the copper particles into oxidized copper compounds.

The commercial ore is not present indefinitely throughout the lodes; it occurs, instead, in more or less well-defined shoots, though these may be very large. The conditions especially favorable for the occurrence of oreshoots appear to be (a) a thorough-going channelway of high permeability, afforded by an open-textured conglomerate, a brecciated lava top, or an unusually vesicular cellular lava top, and rarely by fractures; (b) hematite content of the immediately adjacent rock—not so immediate near some of the cross-cutting fractures; (c) proximity of a barrier of lower permeability inclined diagonally upward across the channelway, so as to concentrate greater volumes of solution into a given volume of rock. The richness of the greatest shoot in the district, the Calumet conglomerate, we attribute largely to this funneling action on the solutions as they ascended into the narrower and thinner part of the conglomerate lens.

Except for the influence of local structural conditions, which may be favorable or unfavorable to change upward as well as downward, the deposits appear to be unchanged in character or richness from the outcrops to the deepest levels, and in our opinion oreshoots of the present grade will be found to continue downward for further long distances. The rock temperatures in the deepest workings are so moderate as to promise no serious inconvenience on that score at considerably greater depth, and there is nothing in the ore or the rock to vitiate the air. The water problem in the deepest levels is inconsiderable. If the problems arising from increasing rock pressure can be solved, as we believe they can, and if exploration for the deep extensions of oreshoots is pursued with due understanding of their nature and behavior, profitable mining ought to continue a long way below the present mine bottoms.

We find no evidence of leaching at or near the surface; numerous shoots were as rich at the outcrops as they or any others are at depth. We find, further, no change in character or grade that can be ascribed to present surface, present water level, present position of the water zones of various compositions or any particular depth.

Numerous deposits of native copper throughout the world show similarities to the Michigan deposits; they are in red rocks, either sediments or the red tops of lavas, and these red rocks are bleached near the copper; sulphides are usually present.

Any hypothesis to account for the deposits of native copper must recognize that they are practically all in red rocks, whereas of the thousands of deposits in limestone and in monzonite and allied rocks none contain primary native copper.

A. C. Lane Argues for a Different Theory of Origin

Taking up a thesis for the origin of the ores diametrically opposed to that of the authors of the paper above quoted, Prof. Alfred C. Lane, of Tufts College, argued in favor of the belief that the copper ores had been leached from the basalts and conglomerates by sea water, an explanation which he had presented as early as 1906. Prof. J. Volney Lewis, of Rutgers College, contributed a discussion on "Similarities and Contrasts Between Native Copper Deposits in New Jersey and Michigan"; and Prof. Joseph T. Singewald, Jr., of Johns Hopkins University, discussed the "Genetic Comparison of the Michigan and Bolivian Copper Deposits." The general opinion of the symposium was that there is a great similarity of origin for the Lake Superior deposits, the copper deposits of New Jersey, and those of Corocoro, Bolivia; that all were due to ascending solutions of magmatic origin. Mr. R. C. Wells, of the U. S. Geological Survey, discussed the origin of the Lake Superior ores from the standpoint of chemistry.

For the meeting of Dec. 30, President J. E. Spurr called the meeting to order and turned the session over to the Vice-president Andrew C. Lawson. A number of highly significant papers were presented briefly and in quick succession. Dr. David White presented a paper on certain Devonian mother-plants of petroleum, which are very important in the study of the genesis of petroleum.

Mr. Willis T. Lee, of the U. S. Geological Survey, delivered a paper on the "Correlation of Oil-Bearing Rocks in Colorado and Wyoming." Prof. Bailey Willis, of Leland Stanford University, discussed "Criteria by Which to Determine the Direction of Faults." Professor Cook, of the University of Wisconsin, described the capillary relationship of oil and water. Mr. E. F. Bean, of the Wisconsin Geological Survey, presented a sound economic-engineering paper, on the application of geology to road building in the state of Wisconsin.

Mr. B. S. Butler brought forward a "Suggested Explanation of the High Ferric Iron Content of Limestone Contact Zones." Prof. W. S. Bayley, of the University of Illinois, described "The Titaniferous Iron Ores of Western North Carolina." Prof. Alan F. Bateman, of Yale University, described primary chalcocite from the Bristol copper mine, in Connecticut, and Prof. L. C. Graton, of Harvard University, brought forward an explanation of the pressure by which certain veins may have been able to force their way into the rocks. Prof. Frank F. Grout, of the University of Minnesota, described "Magnetite Pegmatites in Northern Minnesota," and also "Ladder Veins in Minnesota."

Following this Messrs. Alfred Wandke and Robert Hoffman presented a most valuable short contribution throwing an entirely new light on the nickel deposits at Sudbury. The granite walls of certain sulphide veins (copper and nickel sulphides) in the Creighton mine show an alteration to hornblende, biotite, albite, and quartz. Also, sections were exhibited showing that the orebodies do not follow closely the igneous contact, but diverge from it into the intruded rock. These two bits of evidence seem to dispose of the long-accepted theory that the nickel ores of Sudbury were directly segregated out of a basic magma, along its contact; and to prove that, though of magmatic origin, they ascended "from below."

Mr. Sidney Paige, of the U. S. Geological Survey, imparted new information concerning the Homestake orebody, showing that certain beds of a closely folded series of pre-Cambrian metamorphic carbonate rocks have been selectively replaced by sulphides and gold. The form of the orebodies is determined by a series of compressed anticlines and synclines. The main ore deposition has been believed to be pre-Cambrian; but there is some ore deposition associated with a Tertiary intrusion of porphyry. Mr. J. J. Runner also described the Homestake mine, his interpretation agreeing very closely with that of Mr. Paige.

The next meeting of the society will be held at one of the Atlantic seaboard cities. The date has not yet been announced.

Papers for Meeting of A.I.M.E. in New York Announced

Program of Technical Sessions Covers First Three Days—Scheduled to Start Promptly

The tentative program of the New York meeting of the American Institute of Mining and Metallurgical Engineers, which is to be held the week of Feb. 19, includes the following papers:

Feb. 19, Morning

"A Study of Subsidence at Miami, Ariz." By J. Parke Channing.

"Ground Movement and Subsidence at Inspiration Mine."

"Subsidence in Coal Mining." By H. N. Eavenson.

"Subsidence in Southwest Coal Mines."

"Problems of Ground Movement and Subsidence." By George S. Rice.

"Economic Application of Zonal Theory of Primary Deposition of Ores." By John Carter Anderson.

"Magnesite Deposits of Quebec." By George W. Bain.

Feb. 19, Afternoon

PETROLEUM

"Action of Mud-Laden Fluids in Wells." By Arthur Knapp.

"Relation of Bonuses and Costs to Present-day Prices of Crude and Its Products." By Thomas Cox.

"Sunburst Oil and Gas Field, Montana." By Dorsey Hager.

"The Cannel Coal and Shale Deposits of Pennsylvania." By C. R. Fettke.

"Development in the Isthmus of Tehuantepec Region."

"Centrifugal Machines in the Oil Industry."

DRILL STEEL

"Review of General Status of Drill Steel Breakage and Heat Treatment." By F. B. Foley, C. Y. Clayton, and Henry S. Burnholz.

"Hardness and Heat Treatment of Mining Drill Steel Shanks." By C. Y. Clayton.

METALLURGY

"Heap Leaching at Bisbee, Ariz." By G. D. Van Arsdale and A. W. Hudson.

"Soluble Silica in Preparation of Zinc Sulphate." By J. O. Betterton.

"Pyrite Smelting and Basic Converting." By Kenzo Ikeda.

INSTITUTE OF METALS LECTURE

"Solid Solutions." By Walter Rosenhain.

Feb. 20, Morning

MINING METHODS

"Mining Methods at Marquette."

"Standardizing Mine Maps." By D. B. Gillies.

"Classification of Mining Methods."

Feb. 20, Afternoon

INSTITUTE OF METALS DIVISION

"Occurrence, Chemistry and Uses of Selenium and Tellurium." By Victor Lenher.

"Nature of Solid Solutions." By Edgar C. Bain.

"Cores in Crystals and Metallic Compounds." By Edgar C. Bain.

"Determination of Gases in Metals." By Harold L. Simons.

"Polishing Aluminum and Its Alloys for Metallographic Study." By E. H. Dix, Jr.

JOINT SESSION, IRON AND STEEL WITH COAL AND COKE

"Design and Operation of Roberts Coke Oven." By M. W. Ditto.

"Forms of Sulphur in Coal and Their Relation to Blast-furnace Reactions." By A. R. Powell.

"Combustion in Fuel Beds of Blast-furnace Cokes." By R. A. Sherman and John Blizzard.

"Combustion of Coke in the Blast Furnace Hearth." By G. H. J. Perrott and S. P. Kinney.

"Use of Magnetic Ore in the Blast Furnace." By G. P. Pilling.

MINING METHODS

"Hecla Mining Co." By James F. McCarthy.

"Morning Mine."

"Mechanical Loaders at Underground Mines." By C. E. Barneolt.

"Tunneling Methods on Rhine Canal." By M. Mathieu. Illustrated.

Feb. 21, Morning

IRON AND STEEL

"Continued Discussion on Physics of Steel." By W. R. Webster.

"Specifications for Foundry Pig Iron." By Richard Moldenke.

"Influence of Temperature, Time and Rate of Cooling on Physical Properties of Carbon Steels." By H. M. Howe, F. B. Foley, and J. H. Winlock.

MINING METHODS

"Copper Range Co." By W. H. Schacht.

"Lake Superior Copper." By F. W. Denton.

"Liquid Oxygen Explosives." By Galen H. Clevenger.

"Cripple Creek District." By Fred Jones.

"Telluride District." By Charles Bell.

Joint Meeting Industrial Relations Committee and Mining Section of National Safety Council

"Hoisting Ropes and Safety Devices for Mine Shafts."

Feb. 21. Afternoon

INSTITUTE OF METALS

"Study of Bearing Metals." By C. H. Bierbaum.

"Tests on High Tin Bearing Metals." By P. W. Priestley.

"Some Observations on Occurrence of Iron and Steel in Aluminum." By E. H. Dix, Jr.

"Bright Annealing of Copper Wire." By P. E. Demmler.

"Thermal Conductivity of Some Industrial Alloys." By H. M. Williams.

Technical Education to be Discussed at Joint Meeting with Mining and Metallurgical Society.

"Practical Results Obtained from Psychological Tests at Columbia." By Prof. Adam Leroy Jones.

"Relation of the Mining Industry to Technical Education and to the Technical Graduate." By Prof. F. W. McNair.

Joint Meeting of Industrial Relations Committee and Mining Section of National Safety Council

"Mine Fire Prevention."

"Preparation for Fighting Mine Fires."

"Industrial Psychiatry." By Dr. Jau Don Ball.

"Industrial Relations, Tennessee Copper Co." By J. N. Houser.

"Industrial Community Problems at Brewster." By H. L. Mead, American Cyanamid Co.

MEN YOU SHOULD KNOW ABOUT

Bulkeley Wells is in San Francisco and expects to leave soon for Colorado.

N. O. Lawton, of Salt Lake City, is making a month's visit at Lawton, Mich.

Ira B. Joralemon, now of San Francisco, has been making a geological examination of the Ahumada Lead Co.'s mines in Chihuahua, Mexico.

W. H. Blackburn, general manager of the Tonopah Mining Co. of Nevada, is in Ophir, Utah, where the company is doing some exploration work.

William Spence Black has returned to Boston from a three weeks' trip to the Black Hills in South Dakota, where he examined property for Boston interests.

A. F. Brigham, general manager of the Hollinger Consolidated mine of Porcupine, Ontario, is in Toronto in connection with negotiations with the Provincial government for a power concession.

Alexander Leggat has resigned as superintendent of the Richmond mine, at Adair, Idaho, and will spend the winter in Spokane and vicinity. His permanent address, however, will continue to be Butte, Mont.

Charles Mayotte, who has been for the last two years foreman of the Consolidated Virginia and Ophir mines on the Comstock lode, has resigned. He is succeeded by **William B. Daniel,** foreman of the Mexican mill.

George C. Klug, general manager for Bewick, Moreing & Co., in Australia, and president of the Australasian Institute of Mining Engineers, was in San Francisco late in December on his return from London to Melbourne.

C. M. Garrison, of New York City, has been spending the holidays at Bayard, N. M., as the guest of Alford Roos. He has been looking over mining possibilities of Grant County. **John A. Schermerhorn,** of Orange, N. J., is expected to join him this week.

W. W. Williams, owner of the Deming fluorspar mine, has returned from a week's visit of inspection of the lead-silver deposits near Central, N. M., and at the same time taking advantage of the proximity of the Chino mine to look at the spectacular pit mining there.

Raymond Guyer, vice-president of the Rex Consolidated Mining Co. was elected president of the Columbia Section of the American Institute of Mining and Metallurgical Engineers after the annual banquet at Spokane. **Charles W. Newton,** general manager of the Callahan Zinc-Lead Co., was elected vice-president, and **L. K. Armstrong** was re-elected secretary-treasurer.

Mining and metallurgical engineers visiting New York City included: **H. A. Wheeler,** of St. Louis; **Ernest F. Burchard,** of Washington, D. C.; **H. S. Badger,** of Bridgewater, Nova Scotia; **Alexander Grosberg,** of St. Louis; **D. A. Lyon,** of Washington, D. C., and **W. H. Staver,** of Idaho Springs, Colo.

THE MINING NEWS

The Mining News of ENGINEERING AND MINING JOURNAL-PRESS is obtained exclusively from its own staff and correspondents, both in the United States and in foreign fields. If, under exceptional conditions, material emanating from other sources is published, due acknowledgment and credit will be accorded.

Leading Events

BUTTE apparently will have another "apex" suit. The Anaconda Copper company has started an action against the Davis-Daly company to recover $2,000,000 for ore alleged to have been wrongfully extracted and to stop further mining in disputed territory.

The Colorado Industrial Commission has "awarded" a wage increase of 50c. per day to Leadville miners. Operators will abide by the decision.

The Silversmith mine, in British Columbia, is flourishing.

The Premier Gold Mining Co. has declared another dividend of $750,000. This brings the grand total to $3,150,000.

At Sacramento Hill, in Bisbee, the Phelps Dodge Corporation has resumed steam-shovel operations. Preliminary work will require several months, after which the mill will be started.

Reports are current of a proposed consolidation of a number of copper mines in the Mason Valley district, in Nevada.

Michigan copper-mining companies hope for 17c. copper—but that is high enough, they say.

The Northwest Magnesite Co. is to increase the force at its mines in Washington, from 150 to 300 men.

A new gold dredge has just been started in Lewiston, Calif.

Stoppelli Heirs Get Possession of Maravillas Mine

Outcome of Long Legal Battle Involving Rich Silver Property at Santa Rosalia, in Chihuahua

REPRESENTATIVES of the heirs of Santiago Stoppelli are said to have obtained possession of the rich Maravillas mine, at Santa Rosalia, Chihuahua, Mexico, the control having been surrended by Van Dyne Howbert, superintendent for the Compania Minera de Naica, presumed to be a subsidiary of the Compania de Minera de Penoles, S. A., which in turn is controlled by the American Metal Co. In anticipation of possible resistance, the representatives of the heirs approached the mining property with a military guard of twenty men from the Santa Rosalia garrison, but no trouble ensued, Mr. Howbert declaring that he was working under instructions and was not responsible for any violation of law if there had been any.

The legal contest that has been waged in the Mexican courts involves the profits, said to be many million dollars, as well as the mine itself. Although the supreme court of Mexico, the highest tribunal of the republic, had decreed that the mining property be restored to the Stoppelli heirs, the Naica Company tried to retain possession of the property and to prevent the enforcement of the decree by obtaining a restraining order from one of the Federal District judges of Mexico.

Stoppelli discovered and denounced the land involved in 1896, and title was vested in him by the government on April 30, 1897. In July, 1896, Stoppelli and Saturnino Gonzales created or attempted to create an anonymous partnership under the name of Compania Minera de Naica, S. A., for the purpose of exploiting the mine. Under the Civil Law an anonymous company, usually having the letters "S. A." in its title, is a partnership. It was provided that the joint capital was to consist of the mine and 2,000 pesos in cash, which sum of money was to be represented by 100 shares of fully paid up stock. According to the Stoppelli representatives, he, by virtue of contribution of the mine, was to have 100 shares of fully paid up stock. Apparently, Stoppelli never received a certificate for this 100 shares, although he did receive a certificate for twenty-five shares of non-assessable stock, for which he is alleged to have paid 500 pesos in cash. Subsequently he lost these twenty-five shares through failure to pay assessments which his representatives claim were illegally made because of non-assessability. They claim, also, that the original contract was null because of failure to comply in many particulars with the statutes relating to the organization of an anonymous company. On these grounds the suit was begun by the heirs of Stoppelli.

The principal defense of the American Metal Co. through the Naica Company was that original nullity had been waived by prescription and that the claim was outlawed by the statute of limitations. It is also claimed that a compromise was reached with the Stoppelli heirs in 1904, by which, in consideration of the payment of 30,000 pesos, all claims were released. The reply is that the heirs were minors at the time and that the settlement was unauthorized and not approved by the courts. The company maintains, furthermore, that the plaintiff sold 95 per cent of the alleged interest to a coterie of influential politicians. This is denied by counsel for the Stoppelli heirs. The heirs contended that the Naica Company never received title to the mine itself, but merely obtained the right to exploit the property. They contend that there is no evidence whatever that Santiago Stoppelli ever transferred the fee right to the mining property. It is contended that the records of the Mexican Department of Industry officially show that Santiago Stoppelli is owner of the mining land known as Maravillas.

The American Metal Co. contends that American investors have been dealt with unjustly by the Mexican courts, and has made representations to the state department at Washington which may give the affair an international significance.

Premier Has Paid $3,150,000 —Latest Dividend Jan. 3

The Premier Gold Mining Co., operating in the Portland Canal district, in British Columbia, paid a dividend of 15c. per $1 share on Jan. 3. There are 5,000,000 shares, making the distribution $750,000. The total paid to date is $3,150,000, although the mine has been operated intensively for less than three years.

Anaconda Company Starts Suit Against Davis-Daly

Claims $2,000,000 for Ore Already Mined by Latter From Veins Alleged to Apex in Anaconda Ground

Damages for the alleged illegal extracting of ore worth $2,000,000 are asked by the Anaconda Copper Mining Co. in a suit instituted against the Davis-Daly Copper Co. as reported in the *Journal-Press* of Dec. 30. Anaconda bases its claim on the ground that the vein from which the ore was taken apexes in claims owned by it, and which adjoin Davis-Daly's Colorado claim on both sides. Anaconda also seeks to enjoin Davis-Daly from continuing mining in the disputed territory.

More than a year ago the question arose as to the apexing of some of the veins from which the Davis-Daly was mining profitably 6 per cent copper ore on various levels below 1,900 ft. Engineers and geologists for both companies have been at work since studying the geology with a view to establishing a hypothesis with which to prove ownership for their clients. Last October a conference was held in Butte at which Anaconda disclosed its geological findings, its contentions, and its intentions. It offered Davis-Daly a chance to compromise by a division of the ground in question, but the offer was refused. The offer would have left Davis-Daly a large amount of profitable mining ground, would have saved expensive litigation, and permitted the company to continue in operation. The only recourse now left is a long drawn-out "apex" suit in the courts.

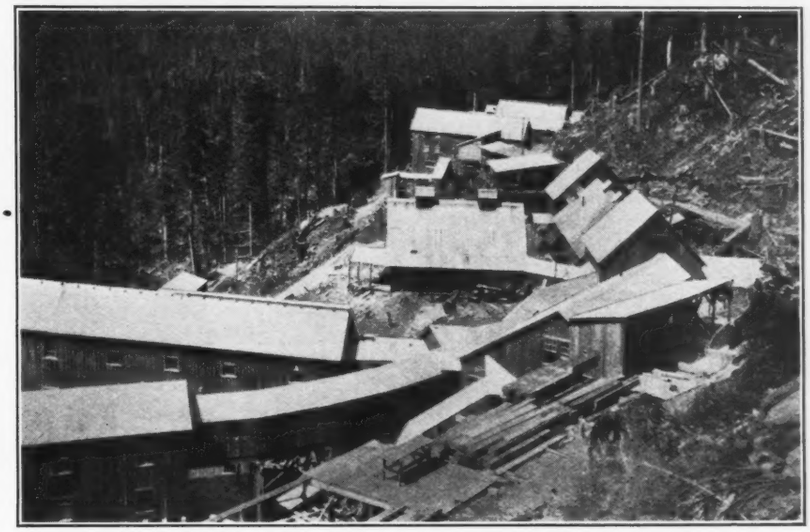
While the Davis-Daly company also owns the Hibernia mine, the Colorado mine is its most important asset. Since J. L. Bruce became general manager in 1919, a great deal of money has been spent in improving the surface plant and equipment. Old machinery was overhauled and new machinery was purchased. A new octagonal ventilating shaft was sunk from the surface to the 1,800 level, which served to improve working condition underground and permit more economical operation. Losing of the suit would be a severe blow to Davis-Daly, and if Anaconda's claim for damages is sustained, the Davis-Daly company will probably face reorganization.

Consolidation of Copper Properties at Mason Valley, Nev.

Semi-official reports from authoritative sources at Reno, Nev., state that plans are being completed for a consolidation of the most important copper mines in the Mason Valley mining district, in Lyon County. The mines affected are the Bluestone, Mason Valley, McConnell, Malachite, Western Nevada, and Nevada Empire. All of these properties are known to have important developed deposits of copper ore. Negotiations are being handled by Robert M. Atwater, formerly of Butte, now associated with a New York investment banking corporation.

Michigan Copper Production

Refined copper production in the Michigan district in December was approximately 11,400,000 lb., or slightly more than 50 per cent of "normal" for the district. The output by mines in pounds was as follows: Calumet & Hecla group, 7,300,000, of which Calumet & Hecla proper produced 5,000,000 lb.; Ahmeek, 1,800,000, and Isle Royale, 500,000; Copper Range, 2,000,000; Mohawk, 900,000; Quincy, 900,000; and Wolverine, 300,000. Mohawk, Ahmeek, and Copper Range show an increase.



Buildings at the Premier mine, in British Columbia

Feldspar and Radium May Be Mined Together

Radium-bearing pegmatites in various districts in Ontario, Canada, will eventually be profitably exploited, according to H. V. Ellsworth, who has made a report on the deposits. He states that the pegmatites of the province undoubtedly contain in the aggregate a relatively enormous amount of radium and thorium minerals, but these occur in a widely disseminated condition. Low-grade ore containing a pound or two of uranium oxide to the ton might under certain conditions prove workable, the tailings constituting a refined ground feldspar product that would be the main source of revenue, while the uranium minerals would be a byproduct obtainable probably at a little extra expense. The application of a concentration process would remove not only the radium minerals, but also various impurities, such as magnetite, ilmenite, pyrite and tourmaline, thus improving the quality of the feldspar product and enabling deposits to be worked on a large scale. Such operations, however, could probably be successfully carried on only by a company with sufficient capital to produce and market ground feldspar in large quantities, mine mica, and recover and refine the rare mineral byproducts.

Industrial Commission Awards 50c. Raise to Leadville Miners

Employees Appealed to Board as Alternative to Striking in December —Operators Will Comply

Leadville—The decision on the appeal of the miners of this district to the Colorado Industrial Commission for a 50c. increase in wages was announced Dec. 24, the award stating that it is the order and decision of the Commission that the employers do, commencing January 1, 1923, increase the wages paid to their respective employees in and around their mines operated in and near the town of Leadville by the sum of 50c. per day per each employee. A strike had been called but the employees concluded to try the commission first. The wage scale prior to January was $3.50 for muckers and trammers and $4 for machine men. The order will effect also the Aspen district as there was an agreement there that the operators would meet the Leadville scale. The advance restores in practically all of the mining camps of the state, the 1921 scale. A general cut in the wage scale of 50c. was made in March 1922, but in most of the camps it was found necessary the latter part of the year to restore the old wage scale in order to retain a working force. Practically all operators will comply with the order.

Pittman Act Silver

Purchases of silver by the Bureau of the Mint during the week ended Dec. 30, 1922, amounted to 1,840,000 oz. This brings the total purchases under the Pittman Act to 150,750,912 oz.

Rhodesian Gold Output

By Cable from Reuters to "Engineering and Mining Journal-Press"

London, Dec. 31—The production of gold in Rhodesia during November totaled 53,255 oz.

Silversmith Mines, Ltd., Has Opened New Ore and Is Producing Profitably

Operates Old Slocan Star Mine, in British Columbia—Purchased and Remodeled Ivanhoe Mill—Dividends Resumed in June

By F. H. Mason

THE rejuvenation of the Slocan Star—one of the old-time banner mines of the Slocan mining district, in British Columbia—to a dividend-paying basis goes to show that the last pulse-beat of a mine cannot be determined with the same degree of accuracy as can that of a human being. Today, as the Silversmith, the name by which it now is generally known, the mine probably is in a better position than at any other time in its history. A net profit of $83,350.57 was made in four months up to Sept. 30, 1922. Slocan Star was located in 1891, and in the twenty-five years that followed ore and concentrate to the value of more than $2,000,000 was shipped from the mine. By far the greater part of the period the zinc content, instead of being an asset, as it is today, stood as a penalty against the value of the silver and lead in the ore. Owing to long and costly litigation, the old owners—the company was reorganized twice before the Silversmith Mines, Ltd., took the mine over—did not receive profits in any way commensurate with the large output.

Silversmith concentrator and lower tram terminal

Two immense oreshoots have been stoped out from the No. 10 level to the surface, a distance of 1,200 ft. on the dip of the vein (about 47 deg.) and a third and smaller shoot has been stoped out from the No. 5 level to the surface. This smaller shoot has not been found in the lower levels. The shoots were lenticular, ranged from 5 to 80 ft. in thickness, and 100 to 350 ft. in length. They pitched at an angle of about 45 deg. The ore consisted of galena, sphalerite, and pyrite in a gangue of quartz, crushed slate, and siderite. For the most part the minerals were intermixed so intimately that they could be separated only by crushing and concentration. Here and there, however, bands and bunches of clean galena were found. The silver was associated with the galena and the blende, and also occurred as distinct silver sulphides.

In May, 1918, Silversmith Mines, Ltd., composed mainly of Spokane shareholders, was organized to take over and explore the mine. The old company's operations had been mainly to the east of the bottom, or No. 10 tunnel. The new company started to explore both east and west, concentrating the bulk of its development on the New Silversmith oreshoot, to the west of the bottom tunnel. This shoot now has been well explored on levels 5, 8, and 10, and a raise has been put up from No. 5 level for 110 ft. in good ore all the distance. A double-compartment shaft has been sunk from the No. 10 level on the dip of the vein, and at 92 ft. vertically below, No. 11 level has been driven to explore the shoot for the greater part of its length. The shoot has been partly developed on No. 9 and No. 11 levels, and it is from these two levels that ore to feed the mill is being mined.

The New Silversmith oreshoot is from 2 to 35 ft. wide and from 350 to 450 ft. long. The character of the ore is similar to that found in the other shoots. Between October, 1918, and August, 1922, the production from it was 57,123 tons of milling ore, averaging 20.5 oz. of silver per ton, 9.3 per cent lead, and 9.1 per cent of zinc; and 1,006 tons of shipping ore, averaging 115 oz. of silver per ton and 60 per cent lead. The assured ore still remaining in the shoot is estimated at 175,000 tons, and the "possible" ore comprises that above the top of the raise from No. 5 level to the surface, a distance of 300 ft., and everything below No. 11 level. Exploration on the vein is being continued in an easterly direction, in the hope of finding other oreshoots. The ore in sight should keep the mill running at its present rate, 3,000 tons per month, steadily for the next five-year period.

The Silversmith company brought the mine to the dividend-paying stage in September, 1921, and one dividend of $25,000 was disbursed, but, as the price of lead had reached a very low level at that time, and zinc concentrate was practically unsalable, it was decided to close the mine and to save the ore reserve for a more favorable market. It was found too that the old mill was inadequate, both in capacity and design, to treat the ore, so the Ivanhoe mill was purchased and entirely remodeled, and a rope tramway, 4,600 ft. long, was built to connect the mine with the mill. Both the mill and the tramway were designed by Erwin V. White. More water power was developed, and the old mill building was turned into a boarding house for the men. Since the mill was started, early in 1922, many further improvements have been added to the flotation department; another boarding house has been added; and a 200-hp. Diesel engine has been installed, to provide against the contingency of severe weather freezing the creeks and greatly diminishing the available water power.

The Silversmith company resumed payment of dividends in June, 1922, and has since paid $50,000, bringing the total dividend disbursements to date up to $75,000.

One feature about the concentration of the ore is interesting: Owing to its tendency to slime, the bulk of the galena is separated from the other constituents of the ore by jigs and tables, with the least possible amount of grinding. The ore is crushed and re-crushed, and is jigged and tabled between each successive crushing, but no attempt is made to separate the blende in these operations, owing to the large proportion of siderite, which is too nearly the same density to permit of effective separation by gravity methods. After the bulk of the galena has been removed, the tailing goes to the flotation department, where first the remainder of the galena is removed, and then the blende is separated from the other constituents of the ore. The flotation concentrates are cleaned, and high-grade lead and zinc concentrates are produced for shipment to the custom smelters.

Steam Shovel Operations Resumed at Sacramento Hill, Bisbee

Announcement has been made by P. G. Beckett, general manager for the Phelps Dodge Corporation at Bisbee, Ariz., that preparations are to proceed at once for the resumption of operations on the Sacramento hill steam-shovel project, where a mountain of copper ore is to be moved. It is expected to take some months to get the production under way. The next few months will be spent largely in drilling the benches and ore will probably not be shipped before May or June. The units of the new 4,000-ton concentrator at Warren will be started up as they are needed. Men will be put on gradually and it will be summer before the full number of approximately 500 men needed for the ore extraction, waste stripping, and mill operation are at work.

Ontario Silver Miners Pay Their Respects to the Boll Weevil

The connection between the boll weevil in Southern cotton fields and the mining industry is emphasized from a new quarter. Silver ores from Cobalt, in northern Ontario, Canada, run high in arsenic, and the high price now obtainable for arsenic is due to the necessity for insecticides to combat the ravages of the boll weevil. A very large part of the revenue obtained by Ontario smelters of Cobalt ores is from the byproducts, which consist of cobalt and arsenic. Owing to the revenue obtained from these sources, smelters are able to offer much better treatment rates than would otherwise be possible. The smelters pay for 98 per cent of the silver in ore running 1,000 oz. or more, and it is stated that if it were not for the revenue derived from the byproducts, the smelters could not afford to pay for more than 95 per cent of the silver.

New Equipment for Mesabi Iron Mines Includes 75-Ton Cars

Many orders have been placed for new equipment to be used in the mining operations on the Mesabi iron range. The McKinney Steel Co. has purchased a No. 300 Marion electric shovel for open-pit operations. Another model No. 300 Marion has been ordered by the Mesabi Cliffs Iron Mining Co., besides three locomotives from the American Locomotive Co., size 19 x 26 in. The equipment of the latter company is to be used on ore operations at its Boeing open pit. Due to the heavy demand for car service of the mine operators on the Great Northern railroad, the company has placed an order for 1,500 ore cars of 75 tons' capacity. Cars of this capacity have been in operation for several seasons and have proved satisfactory. Several cars with a rated capacity of 90 tons were experimented with last season, but no records of results are available. The handling of the iron ore in the Lake Superior region is one of the largest single problems in the transportation field.

News from Washington

By PAUL WOOTON
Special Correspondent

American Sulphur Producers Seek to Extend Their Field

"Gentleman's Agreement" With Italians Likely To Be Broken by Export Corporation

Formation of "The Sulphur Export Corporation" under the Webb-Pomerene Act indicates, in the opinion of officials in Washington, that the three great sulphur-producing concerns have as their objective the domination of the sulphur market of the world. Pressure resulting from overproduction and from the taxation policies of the states of Louisiana and Texas has become sufficiently great to force this coalition among interests heretofore hostile.

Prior to the discovery by Herman Frasch that deeply buried deposits of sulphur could be mined at very low cost when the sulphur was melted with steam and pumped in its molten state to the surface, Italy dominated the world's sulphur market. Now the tables have been turned completely. For many years a gentlemen's agreement is understood to have existed whereby Italy surrendered the important markets of northern Europe to American sulphur on the understanding that no competition was to be offered in southern Europe, and certain other markets which Italy was in a position to supply more readily.

Apparently, the American producers are now prepared to invade their competitors' territory even further. Some are of the opinion that they will be able to lay sulphur down at Mediterranean ports at a price which the Sicilian producers cannot meet. A spectacular industrial clash is expected to result. The Sicilian operations already are subsidized by the Italian Government and there is uncertainty as to whether or not the subsidies will be increased, in view of plans to extend the competition.

In announcing the formation of an export association, the Sulphur Corporation filed with the Federal Trade Commission the following list of officers and stockholders: Clarence A. Snider, president; S. Magnus Swenson, vice-president; James T. Kilbreth, secretary; Charles W. Kemmler, treasurer; Henry Whiton, Eric P. Swenson, Walter H. Aldridge, Wilbur Judson, the Union Sulphur Co., the Freeport Co. and the Texas Gulf Sulphur Co., members.

Upper tram terminal and mine buildings at the Silversmith

House, Strong for Topographic Surveys, Boosts Budget

Unexpected support developed in the House during the consideration of the Interior Department appropriation bill for the item pertaining to topographic surveys. The House, overriding the Appropriations Committee and the Bureau of the Budget, voted to allow $500,000 for topographic surveys in lieu of the $324,500 allowed by the committee. Support for the increase in the appropriation was secured by convincing members of the House that topographic maps constitute basic information necessary for the prosecution of geological work, highway construction, the carrying out of reclamation, drainage, and water-power projects and for the facilitation of various types of public works.

The only fly in the ointment is that this action has antagonized leaders in Congress. Floor Leader Mondell was

frank enough to say that the work will be hurt, rather than benefited, by an increase above the budget. "In every case," he said, "when gentlemen make up combinations to increase an appropriation suddenly, eventually it reacts upon the service. Appropriations in the following years were decreased more than the increase obtained under these sudden pressures."

News by Mining Districts

By Special Correspondents in the Field

Montreal Letter

Promoters Are Called to Time in Ontario—H. S. Denny at Kirkland Lake

BY ALEXANDER GRAY

Montreal, Dec. 31—Following on the warnings issued by Hollinger and Dome directors, and the objection of Nipissing executives to efforts to bamboozle that company's shareholders, the Mining Corporation of Canada has publicly rebuked the Nipissing Extension Co. It has become a habit with agile promoters to capitalize the enterprise of established mining companies. "Gift-bearing Greeks" have been proffering special underwriting privileges to shareholders of this, that and other dividend-paying companies. Rather than have this continue, the artful ones are being given the benefit of publicity they did not anticipate. How far it is permissible to take advantage of the factor of proximity, has legal and moral aspects that are not for discussion here. The promptitude with which culprits have been called to book is further evidence that considerable discriminatory sense has been developed.

Harry S. Denny, is domiciled at the Kirkland Lake Proprietary premises. It hardly is necessary to explain that Mr. Denny did not forego the Christmas cheer and New Year gayeties of London, and betake himself to the bush of northern Ontario, for pleasure. His arrival has not been announced in Canada. The understanding is his mission is a somewhat private one, having to do with the Latilla interests, especially the Tough Oakes and Sylvainte. Incidentally Mr. Denny will avail of the opportunity to visit the Porcupine gold fields. As the apostle of fine grinding, and as a metallurgical engineer whose work in collaboration with that of his brother, George, is now more than ever before the mining world, H. S. Denny may reinforce the recent utterances of J. H. Curle about Ontario and Quebec gold fields. While in New York en route to the north he renewed old friendships with former Randites who recall his 20-year crusade in behalf of the "new metallurgy."

After a brief, inglorious career, New York promoters of the North American Gold Corporation are said to be willing to transfer their rights to others of "safer" and "saner" temperament. The properties have merit; considerable development was done under Coniagas auspices, but things were overdone when the prospectus appeared. Every technical journal promptly condemned the method of presentation—not the mine.

London Letter

Interest Grows in South American Copper Syndicate—Sulphide Corporation Shows Better Profit

BY W. A. DOMAN

London, Dec. 15—Now that the Consolidated Gold Fields of South Africa has made an investment in the shares of the South American Copper Syndicate, a keener interest is taken in the progress of the company. It may, perhaps, be assumed that as John A. Agnew is a director of the Copper Syndicate, and has recently become a director of the Consolidated Gold Fields, it was on his advice that the latter acquired its interest. Hitherto, operations have been conducted on a small scale only; now a policy of a more vigorous nature is to be initiated. Mr. Agnew is an advocate of proving the property by means of the diamond drill. Diamond drilling has proved to be more difficult and expensive than anticipated, owing to the fissures and fractures in the country rock. These conditions are, however, favorable for the occurrence of important masses of ore.

The ore reserves are estimated at 600,000 tons, averaging 4.75 per cent copper. This tonnage is all above the 33-fathom level in the Aroa main orebody. Developments on and below the 40-fathom level, as well as in the Aroa North, Titiara, and San Antonio, orebodies, are opening up a "probable" tonnage, but nothing is yet taken into account. The winze from the 40-fathom level has disclosed a vertical thickness of 52 ft. of solid sulphide of over 8 per cent copper content; crosscuts near the bottom of the winze to the east and the west have discovered a width of 43 ft. of ore (with an intrusion of 5 ft. of barren schist in the west crosscut), of which 20 ft. carried values of over 10 per cent copper. Further development is proceeding, as indications suggest continuity through an area hitherto regarded as barren. Work in this particular section is hampered by water, but the crosscut west has opened up another new make of ore of an average width of 4½ ft. assaying 2⅜ per cent copper. Owing to the low price of the metal, shipments of 2,436 tons of copper matte assaying 20.02 per cent and 4,536 tons of crude ore of 8.4 per cent, failed to cover working expenses, the position being aggravated by the fact that the old smelter plant worked at only 25 per cent of its capacity. Mining ore above the average value had occasionally to be resorted to. The new smelting plant began work on Dec. 11. Its capacity is from 5,000 to 6,000 tons of ore per month. The capital of the Syndicate is only £75,000, in 2s. shares, of which £49,125 is issued.

During the twelve months ended June 30 last, the Sulphide Corporation (Broken Hill) was much more successful than in the previous period. Although working hours were not increased, the efficiency improved considerably, as the tonnage raised weekly averaged 2,319, in comparison with 1,950 in the previous year. After all payments have been made, there is a net profit of £82,832, whereas a year earlier the profit was £30,000, though the bulk of this was miscellaneous revenue and not smelting income.

The experiments that have been made to improve the extraction have had considerable success. The tonnage treated in the refinery was 19,091 tons, from which was obtained 8,689 oz. of gold, 1,700,135 oz. of silver, 16,655 tons of soft lead, and 993 tons of antimonial lead. The combined recoveries from the three sections were 93.1 per cent, silver, 93.5 per cent lead, and 95 per cent of the zinc. Experiments are now being made to improve the recovery of the metals from the slime zinc concentrates, and a similar success is hoped for. The acid and superphosphate plants were in operation throughout 1922. By arrangement with the Electrolytic Zinc Co. of Australasia, a roasting plant at the Zinc company's expense is to be erected at Cockle Creek for roasting the zinc concentrates before treatment in Tasmania.

The Seaton Carew works, which were closed down owing to the coal strike, are now being gradually opened up and spelter is being produced.

MEXICO

Mill Proposed for Cusi Mexican Mining Co. in Chihuahua

Chihuahua—William H. Fink, representing the Cusi Mexican Mining Co., has made a filing on sufficient surface ground near the San Miguel property for the erection of a mill for treating the ores from this mine which belongs to the company. The land requested adjoins the Andres Bunsow property and extends to a point near the mouth of the main shaft. Construction work will begin on the mill soon.

Claude L. Lawton has acquired the Dorada group of mines, in the Lobos Mountains, municipality of Allende, in the northern part of this state. This property comprises nine pertenencias, crossed by a well-defined vein of silver-lead ore. It lies next to the Maria and Romeo mines, which have been worked to a great depth and have produced well.

The Seguridad mine, situated in the Villa Gonzales district, under the jurisdiction of the Juarez mining agency, has recently been taken over by W. T. Houser, of Chihuahua. It is a producer of gold, silver, and lead, and with very little development work can be added to the list of regular shippers of that vicinity. One of the near-by mines is La Mexicana, which has been operated for a number of years.

In this same district Alberto Madero, of El Paso, Tex., has acquired two

properties, which he will work. One of them is the Prosperidad and the other the Anexas a la Prosperidad, both situated in the Colorado Mountains in the vicinity of the Tres Marias, Mosqueteros, and Cerro Colorado mines which produce lead-zinc ores, with some gold and silver values. A number of old shafts exist on the Prosperidad property, some of which are in good ore and will be cleaned out and sunk deeper. This work is to be undertaken within the next month.

Donald B. Best has acquired the Cinco de Mayo mines for the Cia. Exploradora Mexicana. This property produces ores with principal values in silver and lead. It comprises thirty-six pertenencias, situated in the Hueso Mountains, municipality of Villa Gonzales. This company possesses other valuable mine properties in the Chocolate and Lagrimas Mountains of this same region.

Nacozari—The Lone Star Mining Co. has decided to resume development operations at the Santa Elena mine, southwest of El Tigre. T. J. Lawrence will have charge of the work. Though there was no ore on the surface the formation is so favorable that work was started to prove the veins on depth.

Jim Harvey and Mike Sullivan have taken a lease and bond on the Gueriguito mine, about 25 miles south of here, and have made several trips of examination to the mine during the last month. About ten years ago thirty carloads of siliceous ore was shipped to the Douglas smelter, and a small cyanide and table concentration plant was installed. This mine is reported to have a large deposit of low-grade silver ore, and it is said to be a question of putting in a large enough plant to be able to treat the ore economically.

Leo Cloud is making preparations to do some deep development work on the San Nicholas mine, which is about 15 miles west of Cumpas. He will install a hoisting engine and compressor and start down in the old shaft, which now has a depth of 350 ft. The San Nico, as a leasing company took out about 300,000 oz. of silver from the upper levels, treating the ore by flotation. Prior to 1910 the Transvaal company smelted large amounts of this ore at Cumpas.

BURMA

Namtu—During the month of November 16,400 tons of ore were milled in the treatment plant of the Burma Mines, Ltd., producing 9,522 tons of lead concentrate; 10,813 tons of lead-bearing material was smelted in the blast furnaces, producing 3,619 tons hard lead for treatment in the refinery. Refinery products were 3,300 tons of refined lead and 377,943 oz. of refined silver. The ore milled includes 4,100 tons of ore from stockpile. The dry season is at hand and the labor situation is consequently improved. It is hoped that the results in December and January will be materially better than during the past month.

BRITISH COLUMBIA

Mines in Eastern Part of Province Are Active

New Denver—At the Bosun mine development work has been resumed. The mine was a prominent producer in the past, but work was discontinued on account of increased amount of zinc in the lower workings. A large number of men are on the payroll.

Ymir—Activity in the gold mines of the Sheep Creek district has been stimulated by resumption of the Queen mine and amalgamation of the Nugget and Mother Lode mines, which has increased the number of smaller operations. This will be still further augmented on the arrival of spring.

Incline leading to mine of the Moctezuma Copper Co., Nacozari, Sonora, Mexico

Kalso—The strike of high-grade gray copper ore on Tenderfoot Creek by James Comerford, who died recently, is still attracting attention. Ten tons of ore on the dump carries values of from $200 to $3,000 in gold and silver. Norwegian capitalists have bonded the Tenderfoot property of Eric Strand and Ben Lawson. Ore running from $1,400 to $2,000 per ton has been uncovered in the property.

Anyox—Adverse weather conditions have compelled the Granby Consolidated Mining, Smelting & Power Co. to suspend work on its large dam until the spring. The dam stands in places 100 ft. above the bed of the creek; the maximum finished height will be 135 feet.

Nelson — Yellowstone Mines, Ltd., which bought the Queen mine, at Sheep Creek, in the spring, has unwatered and cleaned out the mine. The mill has been overhauled, and new plates have been added. There is said to be a 26-ft. face of milling ore on the No. 6 level. The mine was closed in 1916, following a cave-in, and was not reopened until last spring. The mine has produced gold to the value of more than a million dollars.

ONTARIO

Coniagas Output Declines

Cobalt—The annual report of the Coniagas company for the year ending Oct. 31 shows recovery of 1,158,900 oz., from ore averaging 9.19 oz. per ton. This is a decline of 150,000 oz. in total production, and the grade of the ore was 1.5 oz. lower than in the previous year. The cost of mining and concentrating was 32.6c. per ounce, and the profits were $369,000. During the year the company expended $54,000 examining properties, and at the present has working options in the townships of Coleman, Tisdale, and Bucke, $18,000 being spent in diamond drilling on the Newray property. Options on claims in McVittie Township were allowed to lapse. During the year $200,000 was paid in dividends.

During October the Mining Corporation produced 124,811 ounces from 5,527 tons of ore. Operations were suspended for eleven and a half days owing to power shutdown, due to the fire. Production compared with 173,290 oz. in September. The figures for November, not yet completed, show improvement.

Kirkland — During November the Kirkland Proprietary mill, operating on ore from Tough Oakes and Burnside, treated 2,000 tons and recovered $24,000. The grade is the best for some years and is the result of recent developments on the Burnside property.

In November the Lake Shore treated 1,912 tons and recovered $32,746, an average of $17.10 a ton. This is the highest output since last July. The enlargement of the shaft has been completed, and mining operations are again normal.

Porcupine—McIntyre is treating between 750 and 800 tons per day, of an average recovery of $11 per ton. Developments at the deeper levels continue to be satisfactory.

The dewatering of the West Dome Lake has been nearly completed and underground mining operations will start soon. An auxiliary steam plant has been placed in operation.

NEVADA

Tonopah Extension Has Completed Plans for Increasing Mill Capacity

Tonopah—Bullion shipments from this district, representing results of operations for the first fifteen days of December, totaled $320,000. The Tonopah Belmont shipped bullion valued at $97,000, Tonopah Extension $92,500, West End, $75,000, Tonopah Mining $55,000. The mines were closed down on the 25th and 26th for Christmas holiday, and employees were given suitable Christmas gifts when they called for their regular semi-monthly pay check on the 23d. General conditions in Tonopah are excellent.

The Belmont company, holding an option on a portion of the Buckeye Belmont ground, has ceased drifting on the 1,400 level and resumed sinking to the 1,500.

The new vein, called the North Vein, recently found on the 400 level of the Ohio shaft workings of the West End mine, has been picked up on the 500 level and is producing ore of mill grade.

In the Halifax mine the shaft crosscut to the vein found on the 800 level should be completed by about the middle of January. This connection will improve working conditions and will permit the concentration of development work on the vein.

Developments on the 1,880 level of the Tonopah Extension continue satisfactory, and the orebody is being proved to the west and below the level. Plans are completed for increasing mill capacity from 100 to 500 tons per day.

Eureka—The old Diamond mine in the Prospect Mountain section of the Eureka district has been taken over by the Mackintosh Mining Co., of Salt Lake City. This property has been idle since 1910, but in previous years shipped a considerable tonnage of ore to the Utah smelters. The mine is opened by a tunnel with three 500-ft. shafts and lateral workings from the tunnel level. Supplies and machinery have been ordered, and it is hoped to be able to begin operations before the end of winter.

CALIFORNIA

Lewiston Dredge Will Be Started During First Week of January

San Francisco—Local reports emanating from Grass Valley in which it is stated that a dam is to be constructed at the narrows of the Yuba a short distance below Smartsville, for the purpose of catching debris from hydraulic mining operations, are inaccurate. The proposed dam is one of a series of power and debris dams that will be eventually constructed by the Yuba Development Co. The Bullard's Bay dam is under construction, but just when the other dams will be constructed is indefinite. The project is an huge one, but is dependent upon future developments.

Grass Valley—In the course of shaft sinking at the Idaho Maryland, a promising vein was cut. No values have been found at the exposure, but development is expected to bring interesting results.

Downieville—A new shoot of ore has been struck in the Comet mine in Jim Crow Canyon east of Downieville. Drifts have exposed the ore showing for a length of 70 ft. Additional development is in progress.

Lewiston—The new dredge of the Lewiston Dredging Co. will be placed in operation during the first week of January, 1923.

ARIZONA

Pinto Valley Co. Acquires New Property

Globe—The Pinto Valley Co., a recently organized corporation, of which Garret Mott, of New York City, is president, and T. R. Drummond, of Globe, is general manager, has acquired deeds to a number of mining claims in the vicinity of Pinto creek that were formerly controlled by the Arizona National Copper Co. and the Cactus Copper Co. These holdings together with other claims that have been bought by the corporation constitute a property that extends from a point south of Pinto Creek to the Castle Dome Development Co., to the northeast, in which these men are likewise interested. A new road is now being constructed between the Miami-Superior highway and the Cactus mine which will also serve the Castle Dome mine.

E. W. Mitchell has stated that development work will be started immediately and will be actively prosecuted at the mine of the New Dominion Copper Co., of which he is now president. William Porri, formerly the chief geologist with the Old Dominion company, has been engaged to take full charge of the work. It is the plan of the management to sink the main shaft from its present bottom at the 800 level to the 1,400 level and from that level do systematic development. This company has also taken an option on the Irene mine, which property constitutes nine claims and joins the New Dominion holdings on the north. The New Dominion is said to be amply financed and the work is expected to proceed without interruption.

Wilcox—About 125 men are now employed in the development and equipment of a copper prospect near Wilcox.

Jerome — Development on the 800 level of the Verde Central has continued. The 810 drift has been advanced 80 ft. into ore, the first 60 ft. of which has averaged between 3½ and 6 per cent copper and the last 20 ft. has averaged between 7 and 10 per cent. It is planned to crosscut after the working has advanced 100 ft. in the ore. Preparations are being made to sink the shaft 200 ft. deeper and open the ore on the 1,000-ft. level.

WASHINGTON

Northwest Magnesite Co. Will Employ 150 More Men

Chewelah—The Northwest Magnesite Co. will add 150 men to the payroll the first of the year, preparatory to increasing magnesite production. A like number are already employed in the plant and quarries.

Northport—The Gladstone mine, near Lead Point ,is pushing mining operations on ore recently encountered in development work. The ore in a lead carbonate in the form of chimneys and runs 41 per cent lead. Twelve chimneys have been discovered on the company's property, and production will be increased in the near future if railroad cars can be secured. It is estimated a net monthly earning of $20,000 will result, according to Edwin T. Lavigne, secretary of the company.

Bellingham—Development work at the Boundary Red Mountain mine has added to the developed ore reserve, according to Joseph Pheby, vice-president of the company.

As was indicated by work on the levels above, the principal oreshoot, raking sharply to the south and into the mountain, has disclosed a large block of ore. Development work now in progress continues to add to the length of this block of ore on the 500 level. In advance of winter storms the portal of the new tunnel on the 1,200 level has been constructed, which will enable this work to be pursued. Surveys indicate that from the portal of this tunnel to the intersection of the vein on this level, is more than 1,500 ft.

COLORADO

Colorado Fuel & Iron Co. Will Start Two New Furnaces

Denver—Enlarged operations of the Minnequa plant of the Colorado Fuel & Iron Co. is announced. Two more blast furnaces will be put into operation at once, necessitating increased activity in the coke department and a larger output of the mines. Approximately 1,000 more men will be given employment.

During the week beginning Dec. 17, southern Colorado metal-mining districts experienced one of the worst snowstorms in their history. For the greater part of the week the roads were blockaded and movement of ores entirely ceased. Leadville, Aspen, and the San Juan country were particularly affected.

NEW MEXICO

Andy Strom Property Is Being Developed—Road First Requisite

Bayard—Work on shaft sinking at the Patterson group is progressing rapidly. Stringers of ore have been cut.

Deming—Sam Houghton and associates have finally taken up their option on the famous old Graphic mine at Cooks Peak and have purchased it outright. Work as yet has not been started.

Santa Rita—The Andy Strom property, 25 miles from Santa Rita, in the wilds of the Black Range forest reserve, has been taken over under bond and lease by strong lead-zinc interests from Idaho, and active development is now under way. The only means of access at present is by trail. One of the first things that is being done is to build a wagon road. It is estimated that it will cost $1,2000 a mile. The property has both lead, zinc, copper, and gold ore. Its inaccessability has heretofore prevented development.

Silver City—The concentrating plant of the Cora Miller mine 30 miles north of here on the Gila River, has just been sold. Dismantling will be started.

IDAHO

Idaho Gold & Ruby Co. Involved in Litigation

Bonners Ferry—The Great Northern Railway Co. has filed a petition in the Federal Court asking an injunction restraining the Idaho Gold & Ruby Mining Co. from operating its hydraulic placer mine near Leonia. The railway company alleges damages to its bridge and embankment at the mouth of Boulder Creek by tailings from the operations of the mining company.

Hailey—Stanly A. Easton, manager of the Bunker Hill & Sullivan company, has recently completed an examination of the company's holding near here. Mr. Easton reports the company is pushing exploration on the May Flower and Bullion properties to recover faulted orebodies that were mined years ago. No ore has been found thus far, but work will be continued without interruption until the exploratory work outlined is completed.

Priest River—A strike of high-grade silver-lead ore was made recently in the Cuban Mountain Co.'s property near here. The strike was made in the lower workings, and preparations are being made to start shipments to the smelter, according to L. E. Van Winkle, president of the company.

MINNESOTA

Lincoln Mine Operations Will Be Expanded

Hibbing—All operations at the Morris mine, operated by the Oliver Iron Mining Co., have been suspended until the shipping season of 1923 is opened. The operations were greatly curtailed at this property at the close of the last shipping season, but stripping work and incidental work was continued up to the present.

Virginia—The Interstate Iron Co. has announced the reopening of its Lincoln mine at full capacity. At present only sufficient men are employed for the preliminary work of placing the property on a production basis, as the mine has been closed for over a year. More men and a night shift will be added in the near future.

UTAH

Tintic Standard Operations for 1922 Were Profitable

Bingham—The Utah Copper is working nine steam shovels and mining about 20,000 tons of ore daily. Operations were continued over the holidays, so as to keep the mills supplied with ore. The fifth flotation unit of the Magna mill is expected to be ready for operation soon.

Eureka—Tintic shipments for the week ended Dec. 23 amounted to 188 cars. Shippers are: Chief Consolidated, 62 cars; Tintic Standard, 42; Dragon, 19; Eagle & Blue Bell, 13; Colorado, 12; Victoria, 9; Iron King, 4; Mammoth, 4; Swansea, 3; American Star, 2; Centennial-Eureka, 2; Bullion Beck, 1; Empire Mines, 1; Little May, 1. The Eureka Hill—lately absorbed by the Chief interests—is now open to lessees. The shaft has been retimbered to the 900 level, a new hoist installed and an airline put in connecting with the Chief's compressor plant. There is considerable ore in sight, in bunches, and the upper levels are regarded as a promising ground for the reason that they have produced heavily in the past, without intensive development.

A preliminary financial statement by the Tintic Standard for 1922 shows liquid assets of the company as $419,463, in addition to a cash reserve for taxes of $127,990 and after payment of current dividends of $117,470. Revenue from mill ore for the first ten months is given as $801,965 and the estimated revenue for the last two months is set at $135,812, making the total for the year $937,778. Current dividend brings the total disbursement to stockholders to $1,838,205. In addition, there has been paid $550,000 for construction of a railroad, and $350,000 for a mill. Shipments of smelting ore for the year were 96,163 dry tons. Average assays of 19,127 tons of silver-lead-ore were: 0.024 oz. gold; 35.59 oz. silver; 22.45 per cent lead and 0.43 per cent copper; 11,477 tons of siliceous silver ore assayed 0.538 oz. gold; 37.94 oz. silver; 4.83 per cent lead, 0.70 per cent copper; and 65,558 tons of milling ore averaged 0.03 oz. gold; 16.58 oz. silver; 4.43 per cent lead and 0.39 per cent copper. Shipments of smelting ore up to November brought $1,269,627, and with December estimated, amounting to at least $45,087, there was a total production of smelting ore at a value of $1,314,714.

Park City—Shipments for the week ended Dec. 23 amounted to 3,516 tons, compared with 3,409 tons the week preceding. Shippers were: Park-Utah, 1,093 tons; Park City Mining & Smelting, 1,030; Silver King Coalition, 878; Ontario, 515 tons.

MICHIGAN

Michigan Companies Hope for 17c. Copper; Higher Prices Would Retard Consumption

BY M. W. YOUNGS

Houghton—If copper goes to 17c. per lb., as is now predicted by men well informed on copper trade conditions, the price will be satisfactory to the copper mining industry in Michigan. Anything above 17c. will, it is feared, bring about a revival of the use of substitutes and retard consumption. No extensive increase in production is possible as long as a shortage of underground labor continues and it is believed by operators here that the present rate of consumption will bring copper up to at least 17c. before many months.

Copper Range produced approximately 300,000 lb. more refined copper in December than in the preceding month, due to the increase in the underground force at the Champion mine, the richest of the group of three, miners from the Trimountain having been transferred to Champion Dec. 1. Refined output for the month was 2,000,000 lb.

Mohawk, due to a betterment in manpower, also produced more copper in December, turning out approximately 900,000 lb. Rock shipments from Mohawk and Wolverine now average about 2,750 tons daily, 900 of which are from Wolverine, and the four heads in the Mohawk stamp mill are now being operated an additional shift a week. It is probable there will be little further change in Mohawk output for the remainder of the winter.

Seneca has started sinking in No. 2 Gratiot shaft, which will be sunk 2,000 ft. to connect with drifts now being driven north from the Seneca shaft. The old hoist will be used until the new power plant is in commission, a matter of only a few weeks. The Gratiot shaft is bottomed at the 13th level. Connection with the Seneca shaft will provide better ventilation for both shafts and make long stretches of stoping ground available. It is expected it will take at least 15 months to sink the shaft the required depth. The shaft is being equipped for speed in hoisting once production starts. As stations are cut at the mouth of each level, pockets will be put in, and into these the rock will be automatically dumped from the tram cars instead of directly into the skip. The skip will be filled from the pockets and no time will be lost. Gratiot's new hoist has a capacity of between 3,800 and 4,000 ft. and will hoist a 6-ton skip at the rate of 2,500 ft. a minute.

Danish pebbles continue to do duty in the Calumet & Hecla regrinding mills, no satisfactory substitute having been found in this country. A cargo of the oval-shaped flint stones was received from Denmark during the season of navigation, and practically a two years' supply is kept constantly on hand. Efforts have been made from time to time to obtain flint in the domestic market but none has ever measured up to the requirements as the Danish pebbles.

THE MARKET REPORT

Daily Prices of Metals

Dec.	Copper, N. Y., net refinery* Electrolytic	Tin 99 Per Cent	Tin Straits	Lead N. Y.	Lead St. L.	Zinc St. L.
28	14.50	37.50	38.75	7.25	7.05@7.075	6.90 @6.95
29	14.50	37.50	38.75	7.25	7.05@7.075	6.90 @6.95
30	14.50	37.75	39.00	7.25	7.075	6.90 @6.95
Jan. 1	.....	.....	.....	....	....	.....
2	14.375@14.50	37.75	39.00	7.25	7.125	6.90 @7.00
3	14.375@14.50	37.375	38.625	7.25	7.125	6.90 @7.00

*These prices correspond to the following quotations for copper delivered: Dec. 28th, 29th, and 30th, 14.75; Jan. 1st and 2d, 14.625@14.75.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. Copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Tin quotations are for prompt deliveries. Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

The quotations are arrived at by a committee consisting of the market editors of *Engineering and Mining Journal-Press* and a special representative of the Federal bureaus in Washington which are interested in the mining industries.

London

Dec.	Copper Standard Spot	Copper Standard 3M	Copper Electrolytic	Tin Spot	Tin 3M	Lead Spot	Lead 3M	Zinc Spot	Zinc 3M
28	64½	65½	71½	182⅛	183⅝	26⅜	26⅝	37⅝	34½
29	64½	65½	71¾	182⅛	183⅝	26⅜	26¼	37⅝	34½
Jan. 1	...	...	...	.....	.....	...	...	...	...
2	64⅝	65⅜	71¾	182¼	183¾	26⅞	26½	36½	34½
3	64⅜	65	71½	180⅛	181⅝	26¾	26⅜	36¼	34¼

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver and Sterling Exchange

Dec.	Sterling Exchange "Checks"	Silver New York Domestic Origin	Silver New York Foreign Origin	Silver London	Jan.	Sterling Exchange "Checks"	Silver New York Domestic Origin	Silver New York Foreign Origin	Silver London
28	4.64	99⅝	64⅜	31⅜	1	.....	...	...	31½
29	4.63	99⅝	64¼	31⅜	2	4.64½	99⅝	64½	31⅜
30	4.63⅜	99⅝	64½	31 9/16	3	4.64⅞	99⅝	64⅝	31⅜

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-quarter of a cent premium.

Average Metal Prices for December

Copper:	
New York Electrolytic	14.074
London Standard	63.276
London Electrolytic	70.132
Lead:	
New York	7.163
St. Louis	6.978
London	26.079
Silver:	
New York, foreign	63.825
New York, domestic	99.580
London	31.383
Sterling Exchange	460.440
Zinc:	
St. Louis	6.999
London	37.757
Tin:	
99 per cent	36.480
Straits	37.695
London	178.697
Antimony	6.382
Quicksilver	72.300
Platinum	113.600

Metal Markets

New York, Jan. 3, 1923

The week has been a quiet one as to the volume of sales, owing to the holidays. Prices have varied somewhat, however, with a slight weakening in copper and a stronger feeling evident in lead.

Copper

Copper sales have not been notable during the last few days, but producers are not worrying, for they did such an excellent business in December that they are well sold up and expect a quiet January. In general, all sellers are asking 14.75c. delivered for the next three months, though odd carloads have been sold for an eighth of a cent above this. On the other hand, two or three agencies have been quoting from 14⅝ to 14.70c. on especially attractive business as to tonnage. Foreign demand is quiet, with a resumption of Chinese buying an encouraging feature.

Lead

The official contract price of the American Smelting & Refining Co. continues at 7.25c., New York.

Individual sales have not been great during the last week, but contract requirements at average prices have taken so much of the available lead, and consumers expect such a good spring business, that producers feel that an advance in price is justified. This is also necessary to attract a sufficient portion of Mexican lead to fill domestic needs, inasmuch as the London market has advanced fractionally. The St. Louis market has been somewhat indefinite during the week, owing to the dearth of supplies. Chicago business has been done at approximately the same prices as have been quoted in St. Louis.

Zinc

A slightly increased activity is noticeable in zinc, but prices show only a small change. Brass companies are the major support of the market. Prompt metal remains at 7@7.05c.—a discount of about 5 points per month being given on forward deliveries, in which the major business has been done. There is, however, a greater disposition among consumers to ask for early shipment. New York prices continue at 35 points above those at St. Louis, and high-grade zinc is still 7.75@8.25c., with the usual freight allowances.

Tin

Consumers remain aloof from the market at present prices, and the sales made have largely been between brokers. Most of the 99 per cent grade offered is of Chinese origin. Forward prices are about one-quarter cent above those asked for spot.

Arrivals of tin, in long tons: Total for December, 5,875; Jan. 2, Straits, 1,035; China, 85; Java, 325.

Gold

Gold in London: Dec. 28th, 88s. 11d.; 29th, 88s. 11d.; Jan. 1st, 88s. 11d.; 2d, 89s. 3d.; 3d, 89s. 1d.

Foreign Exchange

On Tuesday, Jan. 2, cable quotations on francs were 7.4275c.; lire, 5.235c.; marks, 0.0141c.; and Canadian dollars, 1⅛ per cent discount.

Silver

The market was held steady in London and New York on account of continued buying by the Indian bazaars. This demand is chiefly for near-by silver, although the future quotation in London is now nearer to spot, which indicates a better tone.

Mexican Dollars—Dec. 28th, 49⅜; 29th, 49; 30th, 49⅛; Jan. 2d, 49¼; 3d, 49⅜.

Other Metals

Quotations cover large wholesale lots, f.o.b. New York, unless otherwise specified.

Aluminum—General market for 99 per cent grade, about 22@23c. per lb. London quotations, £92 10s.

Antimony — Chinese and Japanese brands, 6.35c.; quiet. W. C. C., 6.75@7.25c. Cookson's "C" grade, spot, 7⅞@8⅜. Chinese needle antimony, lump, nominal, 4.50c. per lb. Standard powdered needle antimony (200 mesh), at 5¼c. per lb. White antimony oxide, Chinese, guaranteed 99 per cent Sb_2O_3, 6.75@7c.

Bismuth—$2.45 per lb. London, 10s.

Cadmium—$1.15 per lb. London quotes 5s. 6d.

Cobalt—Metal, $2.65@$2.85 per lb.; black oxide, $2 per lb. in bbls. London quotes 11 to 12s. for metal; black oxide, 9s.

Iridium—$240@$275 per oz.

Magnesium—Sticks, 1⅛ in., 99.9 per cent, $1.25 per lb. London quotes 4s.@4s. 9d. for 99 per cent.

Molybdenum Metal—In rod or wire form, 99.9 per cent pure, $32@$40 per lb., according to gage. Powder, 95 per cent, $4.50 per lb.

Monel Metal — Shot, 32c.; blocks, 32c. per lb., f.o.b. Bayonne, N. J.

Nickel—Standard market, ingot and shot, 36c.; electrolytic, 39c. Outside market quiet at 32@34c. per lb.

Osmium—Pure, $70@$80 per oz. troy, in Los Angeles. Strong.

Palladium—$65 per oz. London, sponge, £11@£12 10s.

Platinum—$118 per oz. London, £23.

Quicksilver—$74 per 75-lb. flask. San Francisco wires $70.70. London, £12.

Radium—$70 per milligram of radium content.

[1]**Rhodium**—$4 per gram.

Selenium — Black powdered, amorphous, 99.5 per cent pure, per lb.

[1]**Tellurium**—$1.50@$2 per lb.

[1]**Thallium Metal**—Ingot, 99 per cent pure, $8 per lb.

Tungsten Metal—Powder, 97 to 98 per cent, $1 per lb. contained tungsten.

Metallic Ores

Chrome Ore—Indian chrome ore at $18.50 per ton, c.i.f. Atlantic ports. Rhodesian and New Caledonian, $23 and $28 per ton. Market quiet.

Iron Ore—Lake Superior ores, per long ton, Lower Lake ports: Old Range bessemer, 55 per cent iron, $5.95; Mesabi bessemer, 55 per cent iron, $5.70; Old Range non-bessemer, 51½ per cent iron, $5.20; Mesabi non-bessemer, 51½ per cent iron, $5.05.

Magnetite Ore—F.o.b. Port Henry, N. Y.: Old bed 21 furnace, $5 per long ton; old bed concentrates, 63 per cent, $5.25; Harmony, cobbed, 63 per cent, $5.25; new bed low phosphorus, 65 per cent, $7.50.

Manganese Ore—30c. per long ton unit, seaport, plus duty; equivalent to about 45c. Chemical ore, $75@$80 per gross ton.

Molybdenum Ore—60c. per lb. of MoS_2 for 85 per cent MoS_2 concentrates, plus duty; equivalent to 85@90c. per lb.

Tantalum Ore—Hand-sorted ore, 70 per cent combined columbite-tantalite, 40c. per lb., South Dakota.

[1]**Titanium Ores**—Ilmenite, 52 per cent TiO_2, 1¼@2c. per lb. for ore. Rutile, 96 per cent TiO_2, 10c. per lb. for ore, with concessions on large lots or contracts.

Tungsten Ore — Wolframite, $7.50; scheelite, $8@$8.50 per unit of WO_3, f.o.b. New York.

Uranium Ore (Carnotite)—Ore containing from 2 to 2½ per cent U_3O_8, $3.50 per lb. of contained U_3O_8.

Vanadium Ore—No quotation. Recently $1 per lb. of V_2O_5 content.

Zircon — Zirconium silicate, f.o.b. Pablo, Fla., 4½@13c. per lb.

Zinc and Lead Ore Markets

Joplin, Mo., Dec. 30—Zinc blende, per ton, high, $45.90; basis 60 per cent zinc, premium, $42@$41; Prime Western, $40; fines and slimes, $39@$37; average settling price, all grades of blende, $43. Calamine, basis 40 per cent zinc, $20.

Lead, high, $96.80; basis 80 per cent lead, $93; average settling price, all grades of lead, $90.81 per ton.

Shipments for the week: Blende, 17,225; calamine, 191; lead, 1,923 tons. Value all ores the week, $918,670. Shipments for the year: Blende, 514,044; calamine, 2,718; lead, 93,451 tons. Value all ores the year, $24,966,640.

Sellers disposed of 7,500 tons of blende for next week's delivery, with the year-end demand lower than for several months.

Purchases reported the year totaled 487,390 tons and shipments are reported at 514,044 tons, indicating an unusually light overload, or less than 7 per cent, whereas 10 per cent overload is allowed by the railroads.

Platteville, Wis., Dec. 30—Blende, basis 60 per cent zinc, $42.50 per ton. Lead, basis 80 per cent lead, $93 per ton. Shipments for the week: Blende, 492 tons; lead, none. Shipments for the year: Blende, 40,350; lead, 1,614 tons. Shipped during the week to separating plants, 1,113 tons blende.

[1]Price furnished by Foote Mineral Co., Philadelphia, Pa.

Non-Metallic Minerals

Asbestos—Crude No. 1, $450@$550; No. 2, $250@$350; long spinning fibers, $150@$250; magnesia and compressed sheet fiber, $125@$175; shingle stock, $60@$80; paper stock, $30@$40; cement stock, $15@$20; shorts, $8@$12—all per short ton, f.o.b. mines, Quebec.

Rhodesian No. 1 crude, $400; No. 2, $250; inferior grade, $200—all c.i.f. Atlantic ports per short ton.

Market quiet for spinning grades and good for shingles, paper, and cement stocks

Barytes—Crude, $8@$8.50 per ton, f.o.b., mines. Ground, off color, $13@$13.50; white, $16@$18, f.o.b. plant. Prime white floated, $24@$28 per ton, St. Louis.

Bauxite—American, crushed and dried, $6@$9 per gross ton; pulverized and dried, $12@$14 per gross ton; calcined, $22@$25 per gross ton, all f.o.b. shipping points. Foreign bauxite offered at $5@$8 per metric ton, c.i.f. Atlantic ports, depending upon grade.

Borax—Granulated and refined, crystals or powdered, in bags, carloads, 5¼c. per lb.; in bbls., 5½c. Boric acid, 11c.

Chalk—English, extra light, 5c. Domestic light, 4¼@4½c.; heavy, 3½@3¾c. per lb., all f.o.b. New York.

China Clay (Kaolin)—Crude, $7@$9; washed, $8@$9; powdered, $13@$20; bags extra, per net ton, f.o.b. mines, Georgia; powdered clay, $14@$20, f.o.b. Virginia points. Imported lump, $15@$20, f.o.b. American ports; powdered, $45@$50, f.o.b., New York. 1A grade, refined, $13.50@$15 per ton, Delaware.

Canadian, in lumps, $16@$18, f.o.b. Quebec points. Demand good.

Diatomaceous Earth — Crude, air-dried material, in large lumps, $8 per ton, f.o.b. California quarries. Ground material for insulation is priced according to density. It is being sold for $35 per ton, having a settled weight of 15 lb. per cu.ft., and $25 per ton for 20 lb. per cu.ft. The highest grade of material, the so-called "air float" or "baghouse," suitable for polishes and similar uses, brings from $75 to $100 a ton. All prices f.o.b. quarry. Material suitable for filtration is not in line with the other grades of powders. Contracts with large consumers are at present in force at a figure as low as $17 per ton, f.o.b. quarries. It is doubtful, however, if contracts could be made at present at less than $20 or $22.50 per ton. The prices quoted on this grade of material depend largely on estimated consumption of the purchaser. All above quotations are on a minimum car basis, a minimum car holding 20 tons of 2,000 lb.

Emery — Turkish and Greek manufactured emery, 6@8c. per lb. American, 3½@5½c. Inferior grades, 3½c., f.o.b. New England points.

Feldspar — No. 1 pottery grade, $6@$7.50 per long ton; No. 2, $5@$5.50; f.o.b. North Carolina points. No. 1, $7.50; No. 2, $6.50; ground, 60 to 80 mesh, $18@$20 per short ton;

120 to 150 mesh, $20@$24; 200 mesh, $25@$30, f.o.b. Connecticut points. No. 1, Canadian, $20 per net ton, f.o.b. Ohio mills.

First quality ground, $21 in New Hampshire, $18 in Maine; second quality, $16 in New Hampshire. In Colorado, No. 1 crude, $5; No. 2, $4.50 per short ton.

Small demand for No. 2 pottery, as the market has been flooded with low-grade material.

Fluorspar — Fluxing gravel, 85 per cent CaF_2 and not over 5 per cent silica, $21.50, f.o.b. mines; not over 6 per cent silica, $21; 80 per cent grade, not over 5 per cent silica, $20; ground acid grade, $45 in bulk; ground enameling grade, $35 in bulk; packages, $4 extra, all f.o.b. mines, Illinois.

Gravel with limestone gangue, $14; lump, 92 per cent CaF_2, $17, f.o.b. New Mexico. Only a few mills active, owing to low prices.

No. 1 lump, $30; No. 2, lump, $25, f.o.b. Illinois mines.

Fuller's Earth—16 to 60 mesh, $19 per ton; 16 to 30 mesh, $17; 30 to 60 mesh, $18; 60 to 100 mesh, $14; 100 mesh and finer, $10; f.o.b. Florida mines.

Graphite—American flake, 4@5c. per lb. at mines. Ceylon lump, first quality, 5@5½c. per lb., plus duty; chip, 4@4½c.; dust, 3@3½c. Mexican crude amorphous, $15@$35, f.o.b. New York.

Prices are lower than they should be for profitable business, owing to large offerings.

Gypsum—Crushed rock, $3 per ton in most states. Ground, $3.50@$4, f.o.b. shipping points.

Kaolin—See China Clay.

Limestone—Crushed, New York State shipping points, ¾ in. and larger, $1.10 @$1.35 per net ton. Agricultural limestone, $2.50@$3 net ton, f.o.b. eastern shipping points.

Magnesite—$14 per ton for crude, $40 for calcined magnesite, f.o.b. California points. Dead-burned magnesite grains, $40 per net ton, f.o.b. Baltimore; $40@$42, Chester, Pa.

Western magnesite industry in a better position. Demand for plastic material is good.

Manjak—Barbados, in 1 to 5 ton lots, grade "C" lump, $330 per short ton; "C" fine, $250; grade "A," $185—all c.i.f. New York.

Mica—Domestic, No. 1 quality, 1½x2 in., 15c. per lb.; 2x2 in., 35c.; 2x3 in., 80c.; 3x3 in., $1.20; 3x4 in., $1.60; 3x5 in., $2; 4x6 in., $2.80; 6x6 in., $3.60, all per lb., f.o.b. North Carolina, thumb trimmed; 1¼ in. disks, 75c. per lb.

Scrap, $22 per short ton; washer, 8@10c. per lb.; disk, 15c. per lb., f.o.b. Connecticut points. Market active.

[1]**Monazite**—Minimum 6 per cent ThO_2, 6@8c. per lb.

Phosphate — 77 to 76 per cent tricalcium phosphate, hard rock, $8 per ton, f.o.b. Jacksonville; 77 to 76 per cent pebble grades, $7.50; 75 to 74 per cent pebble, $6; 70 per cent pebble, $4.50; 66 to 68 per cent pebble, $4.10, f.o.b. Tampa.

Seventy-two per cent washed and unground, $5.50@$6 per long ton; 75 per cent kiln-dried lump, $6.50@$7; 65@70 per cent ground, $6@$6.50 per ton, f.o.b. Tennessee mines.

Pumice Stone—Imported lump, 3@40c. per lb.; domestic lump, 5c.; ground, 5@6c., all f.o.b. New York.

Pyrites—Imported lump, 1 in. diameter and up, 11½c. per unit; furnace size, 2½ in. diameter, 12½c. per unit; fines, through ½-in. mesh, 12c. per unit; cinder property of buyer, ex ship, Atlantic ports. Ore contains 50@51 per cent sulphur; cinder about 63 per cent metallic iron. Market weak.

Silica—Glass sand, generally $2@$2.75 per ton, f.o.b. shipping point; sand-blast material, $2.50@$5. Ground, 250 to 450 mesh, $20@$40, f.o.b. mills. Glass sand, $5@$10, f.o.b. Massachusetts.

Sulphur—$16@$18 per ton for domestic, f.o.b. Texas and Louisiana mines; $18@$20 for export, f.a.s. New York.

Talc—160 to 200 mesh, $6.50@$8.50 per ton, Vermont. Price depends upon color as well as fineness. Paper bags, $1 per ton extra. Burlap bags, 12 to the ton, 10c. each extra, with 9c. return allowance. Market weak. Competition severe. Some contracts for roofing talc for 1923 have been closed at very low prices. Distinctly a buyers' market.

In New York, 200 to 325 mesh, $13.75 @$14.75 per ton for air-floated talc.

In Georgia, white, $7@$9; yellow, $7 @$9; red, $9@$11.

In California, $16@$20 per ton, depending upon fineness and color.

Tripoli—Once ground, rose and cream colored, $16@$25; white, $18@$27; double ground, r. and c., $17@$25; w., $19@$30; air-float, r. and c., $25@$30; w., $35; super air-float, r. and c., $35@$40; w., $40@$45. All per short ton in 200-lb. burlap bags with paper liners, minimum car, 30 tons, f.o.b. Missouri points. Market strong.

Mineral Products

Arsenious Oxide (white arsenic)—firm at 12½@13½c. per lb.

Copper Sulphate — Large crystals, 6c. per lb.; small, 5.90c.

Sodium Nitrate—$2.475 per 100 lb., ex vessel Atlantic ports.

Potassium Sulphate — Powder, domestic, $1 per unit, basis 90 per cent, f.o.b. New York.

Sodium Sulphate—$25@$27 per ton, New York.

Ferro-Alloys

Ferrocerium—Per lb., $15@$20.

Ferrochrome—1 to 2 per cent carbon, 28c. per lb.; 4 to 6 per cent carbon. 12@14c. per lb.

Ferromanganese — Domestic, 78@82 per cent, $100 per gross ton, f.o.b., furnace. Spiegeleisen, 19@21 per cent, $35, f.o.b. furnace; 16@19 per cent, $34.

Ferromolybdenum — $1.90@$2.15 per lb. of contained molybdenum for 50 to 55 per cent grades.

[1]Price furnished by Foote Mineral Co., Philadelphia, Pa.

Ferrosilicon—10 to 12 per cent, $44 @$51 per gross ton, f.o.b. works; 50 per cent, $75@$80.

Ferrotitanium—For 15 to 18 per cent material, $200@$225 per ton, f.o.b. Niagara Falls, N. Y.

Ferrotungsten—90@95c. per lb. of contained W., f.o.b. works. Market firm.

Ferro-uranium—35 to 50 per cent U, $6 per lb. of U contained, f.o.b. works.

Ferrovanadium—$3.50@$4 per lb. of V contained, f.o.b. works. Market very active.

Metal Products

Copper Sheets—New York base, 22.25c. per lb.; wire, 16.50@16.75c. net.

Lead Sheets—Full lead sheets, 10.25c. per lb.; cut lead sheets, 10.50c. in quantity, mill lots.

Nickel Silver—30c. per lb., for 18 per cent nickel Grade "A" sheets.

Yellow Metal — Dimension sheets, 20c. per lb.; rods, 17c. per lb.

Zinc Sheets—$9.25@$9.50 per 100 lb., f.o.b. works.

Refractories

Bauxite Brick—$45@$50 minimum, per net ton, f.o.b. shipping point.

Chrome Brick—$50@$52 per net ton, f.o.b. shipping point.

Chrome Cement — $23 per net ton, f.o.b. shipping point.

Firebrick—First quality, $40@$46 per M., Pennsylvania, Ohio, and Kentucky works; second quality, $36@$41.

Magnesite Brick — 9-in., straights. $65@$68 per net ton, f.o.b. works.

Magnesite Cement — $45@$50 per net ton, f.o.b. shipping points.

Silica Brick—$42@$44 per M., Pennsylvania; $47@$50, Indiana; $48@$50, Alabama.

[1]**Zirkite**—Powdered, $50@$60 per ton; brick, $100 per ton.

The Iron Trade

Pittsburgh, Jan. 2, 1923

The new year opens in the steel market under much more favorable auspices than expected a month or two ago.

Finished steel products are firm at 2c. for bars, shapes, and plates, 2.50c. for blue annealed sheets, 3.35c. for black sheets, 4.35c. for galvanized sheets, 4.70c. to 5c. for automobile sheets, according to delivery; 2.45c. for plain wire, $2.70 for nails and 66 per cent basing discount for merchant pipe.

Pig Iron—Merchant furnaces are firm as to prices and steel works are less inclined than formerly to offer basic iron, expecting heavier requirements in their mills, making basic quotable at $25, Valley, against $24.50 a week ago, foundry remaining at $27 and bessemer at $27.50.

Connellsville Coke—Spot coke has advanced again, by 50c., being now $9@$9.50 for all grades, the advance being due entirely to buying for domestic use. Some furnaces are understood to have got first-quarter contracts at $7@$7.50.

Facts for the Stockholder

I—Chile Copper Co.

THE CHILE COPPER CO. was incorporated as a holding company in Delaware, in April, 1911, with an authorized capital stock of $95,000,000, divided into 3,800,000 shares having a par value of $25 each. All of the stock, excepting nine shares held by the directors, was issued to the Chile Copper Co. of Maine for 10,000 shares of the capital stock of the Chile Exploration Co., par value $100, this being the entire capital stock of the operating company; and water rights, power-plant sites, and other properties, together with about $9,000 cash.

The Chile Exploration Co. owns a considerable part of the known copper deposits of the district of Chuquicamata, near Calama, Province of Antofagasta, Republic of Chile, South America. The holdings comprise 309 mining claims, with an area of 862 hectares (1 hectare = 2½ acres), and 438 other claims having an area of 2,233 hectares.

Reserves of positive and probable ore consist of 327,000,000 tons of oxidized ore, averaging 1.91 per cent copper; 151,000,000 tons of mixed ore, averaging 2.89 per cent, and 210,000,000 tons of sulphide ore averaging 1.84 per cent; with total reserves of 688,000,000 tons of all classes averaging 2.12 per cent copper.

Production of copper in recent years has been 88,000,000 lb. in 1917, 102,000,000 in 1918, 76,000,000 in 1919, 111,000,000 in 1920, 54,000,000 in 1921, and is estimated at about 130,000,000 lb. in 1922. At double this capacity the developed ore reserves would last over 100 years.

Chile's cost of production was as high as 16.75c. a pound in 1917, but since then has been regularly reduced by virtue of improved treatment methods and increased production. The cost dropped to 13.3c. in 1918, was 13c. in 1919, 10.7c. in 1920, 10.8c. in 1921, and 8.365c. in the first quarter of 1922. During the second quarter the cost dropped to 7.077c., and in the third quarter was further reduced to 6.352c., including selling and delivery expense, but exclusive of depreciation and federal taxes, and without any credits from miscellaneous income. December output of copper was probably close to 15,000,000 lb., with direct operating and marketing costs around 5.9c. a pound. Within the next few months it is estimated that Chile will be producing at the rate of about 19,000,000 lb. a month, with operating cost around 5.75c.

The company's funded debt amounts to $49,994,500, consisting of $15,000,000 collateral trust convertible 7s, due May 1, 1923, and $34,994,500 collateral trust convertible "A" 6s, due April 1, 1932. The 7s are convertible at any time into common stock at par with a cash adjustment as to interest and dividends. They were listed on the N. Y. Stock Exchange on June 23, 1915. The 6s are redeemable as a whole only, at 110 and interest on any interest date, and convertible at any time into common stock at $35 a share. It is further provided that if the company issues any other bonds convertible at a lower rate, or stock for less than $35 a share, the present issue will be convertible at such lower figure. Additional $40,000,000 capital stock has been authorized to provide for the conversion of the bonds. Should all the outstanding 7s be converted before maturity, Chile would have outstanding 4,400,000 shares. Following the ultimate conversion of the 6s, about 5,400,000 shares would be outstanding, representing a total capital of $135,000,000.

At the end of 1921, net working capital stood at $20,000,000, and net assets applicable to the stock amounted to about $25 a share, or the par value. Aggregate net income available for dividends up to the end of 1921 amounted to practically nothing. However, the company has been under heavy expense incident to development and equipment during the past several years, and only during 1922 has it reached a condition where it is about to demonstrate its probable stride as the world's greatest and lowest-cost copper producer.

The range of stock since 1915 has been as follows: High, 39¼ in 1916; low, 7⅞ in 1920; close Jan. 3, 28⅜.

INVESTIGATOR.

Refinery Production of Lead in 1922

According to the U. S. Geological Survey, the output of primary domestic desilverized lead in 1922 was about 181,000 tons, of soft lead about 204,000 tons, and of desilverized soft lead about 76,000 tons, making a total output from domestic ores of about 461,000 tons of refined lead, compared with 398,222 tons in 1921, which was made up of 187,962 tons of desilverized lead, 157,513 tons of soft lead, and 52,747 tons of desilverized soft lead. The output of lead smelted and refined from foreign ore and bullion was about 70,000 tons, compared with 50,367 tons in 1921. The total lead smelted or refined in the United States was thus about 531,000 tons, compared with 448,589 tons in 1921. The output of antimonial lead is reported to be about 6,500 tons, against 10,064 tons in 1921. The exports of lead of foreign origin were about 35,000 tons and of lead of domestic origin about 5,500 tons, compared with 34,369 tons and 1,624 tons, respectively, in 1921. The imports of refined pig lead of which statistics are available for the period under the old tariff only (Jan. 1 to Sept. 21, inclusive) were 2,500 tons, compared with 31,301 tons in 1921 and 35,719 tons in 1920. From a total supply of about 533,000 tons of refined lead (exclusive of stocks), there was withdrawn for export about 38,000 tons, leaving 495,000 tons available for consumption in the United States, against 444,872 tons in 1921 and 538,020 tons in 1920.

The average quoted price of lead for prompt delivery at New York for the year was a little under 5.7c. a pound, compared with an average selling price of 4.5c. in 1921. At the beginning of 1922 the price was 4.7c., and it remained at that figure through the first three months. By early June the price had risen to 5.8c., and it stood slightly under this figure until the latter part of August. A gradual rise brought the price to about 7.25c. at the end of the year.

Smelter Production of Zinc in 1922

The output of primary metallic zinc from domestic ores in 1922 was about 338,000 tons, according to the U. S. Geological Survey, and from foreign ores about 1,000 tons, a total of 339,000 tons, compared with 198,232 tons from domestic ores and 2,268 tons from foreign ores, a total of 200,500 tons, in 1921. In addition to primary zinc there was an output of about 24,000 tons of redestilled secondary zinc, compared with 17,573 tons in 1921, making a total supply of distilled zinc and electrolytic zinc in 1922 of about 363,000 tons, of which 95,000 tons was high-grade and intermediate, 46,000 tons select and brass special, and 222,000 tons Prime Western. The output of the corresponding grades in 1921 was 29,080, 47,814, and 141,179 tons, respectively, a total of 218,073 tons. Of the total output of primary zinc in 1922, about 77,000 tons was made in Illinois, against 48,865 tons in 1921; 64,000 tons in Oklahoma, against 41,244 tons; and 73,000 tons in Pennsylvania, against 36,378 tons.

The imports of foreign slab zinc up to Sept. 21, when the new tariff went into effect, no later statistics being available, amounted to 45 tons, compared with 6,739 tons in 1921. No American zinc was returned in 1922, against 731 tons in 1921. Not included in the imports given above is 415 tons of sheet zinc imported and entered for consumption in the first nine months of 1922, compared with 6,688 tons in 1921.

The exports of zinc made from foreign ores were about 2,600 tons and those of zinc made from domestic ores were about 28,000 tons, compared with exports of 1,256 and 3,569 tons, respectively, in 1921. The exports of domestic zinc included about 3,000 tons of sheet zinc, against 1,816 tons in 1921. The stock of zinc at smelters and in warehouses at the end of November was about 15,500 tons, against 70,452 tons at the end of 1921. The apparent consumption of primary zinc in 1922 was thus about 363,000 tons, compared with 203,600 tons in 1921, and 323,043 tons in 1920.

At the end of November 74,692 retorts were reported in operation out of a total of about 150,000 retorts at active plants, compared with 42,200 retorts in operation at the end of 1921. Advices in December put the number expected to be in operation at the end of the year at about 77,000.

METAL STATISTICS

Monthly Average Prices of Metals

Silver

	New York		London		Sterling Exchange	
	1921	1922	1921	1922	1921	1922
January	65.950	65.450	39.985	35.035	372.650	421.750
February	59.233	65.290	34.745	33.891	385.932	435.511
March	56.023	64.440	32.479	33.269	389.806	436.912
April	59.337	66.575	34.250	34.080	391.784	440.715
May	59.810	71.154	34.165	36.023	396.580	444.106
June	58.510	71.149	34.971	35.900	377.236	444.615
July	60.260	70.245	37.481	35.644	362.565	444.165
August	61.597	69.417	38.096	34.957	364.505	446.069
September	66.160	69.515	40.082	35.305	371.725	442.800
October	70.970	68.015	41.442	34.498	386.315	443.583
November	68.234	65.177	38.750	32.882	396.315	447.484
December	65.760	63.825	35.645	31.383	414.880	460.440
Year	62.654	67.521	36.841	34.406	384.191	442.346

New York quotations cents per ounce troy, 999 fine, foreign silver. London, pence per ounce, sterling silver, 925 fine.

Copper

	New York		London			
	Electrolytic		Standard		Electrolytic	
	1921	1922	1921	1922	1921	1922
January	12.597	13.465	70.964	65.226	79.119	72.321
February	12.556	12.864	70.925	60.250	75.925	66.125
March	11.976	12.567	67.565	59.245	71.190	65.739
April	12.438	12.573	69.381	58.799	71.786	64.028
May	12.742	13.111	73.196	61.092	74.298	66.554
June	12.697	13.575	71.852	61.988	75.682	69.333
July	12.170	13.654	71.155	63.137	75.286	70.321
August	11.634	13.723	68.614	63.784	72.705	69.932
September	11.948	13.748	67.977	63.113	72.295	70.917
October	12.673	13.632	67.327	62.773	73.476	70.693
November	13.035	13.598	66.614	62.795	74.386	70.216
December	13.555	14.074	66.706	63.276	74.525	70.132
Year	12.502	13.382	69.356	62.123	74.223	68.859

New York quotations, cents per lb. London, pounds sterling per long ton.

Lead

	New York		St. Louis		London	
	1921	1922	1921	1922	1921	1922
January	4.821	4.700	4.747	4.388	23.387	23.667
February	4.373	4.700	4.228	4.396	20.650	20.681
March	4.084	4.720	4.000	4.421	18.911	21.266
April	4.356	5.115	4.272	4.946	20.589	22.993
May	4.952	5.420	4.784	5.281	23.399	24.462
June	4.485	5.745	4.293	5.563	22.563	24.685
July	4.410	5.729	4.260	5.447	23.399	24.869
August	4.382	5.824	4.217	5.537	23.489	24.580
September	4.600	6.110	4.392	5.868	23.148	24.131
October	4.690	6.530	4.439	6.338	23.679	25.551
November	4.683	7.047	4.356	6.868	24.483	26.199
December	4.700	7.163	4.369	6.978	25.322	26.079
Year	4.545	5.734	4.363	5.503	22.752	24.097

New York and St. Louis quotations, cents per lb. London, pounds sterling per long ton.

Tin

	New York				London	
	99%		Straits			
	1921	1922	1921	1922	1921	1922
January	31.470	31.480	36.000	32.100	190.464	163.065
February	28.534	29.835	32.142	30.767	166.250	149.850
March	27.296	28.426	28.806	29.171	156.024	143.152
April	28.990	29.810	30.404	30.605	163.905	149.840
May	31.431	30.149	32.500	30.971	177.411	150.163
June	28.514	30.707	29.423	31.497	167.506	152.512
July	26.755	31.025	27.655	31.733	164.530	156.149
August	25.662	32.134	26.301	32.380	155.318	160.006
September	26.280	32.075	26.680	32.395	156.750	160.065
October	27.278	33.935	27.655	34.600	156.380	170.563
November	28.592	35.911	28.935	36.734	158.898	179.341
December	32.106	36.480	32.486	37.695	169.738	178.697
Year	28.576	31.831	29.916	32.554	165.265	159.450

New York quotations, cents per lb. London, pounds sterling per long ton.

Zinc

	St. Louis		London	
	1921	1922	1921	1922
January	5.413	4.691	25.262	26.321
February	4.928	4.485	24.850	24.213
March	4.737	4.658	25.077	25.467
April	4.747	4.906	25.530	26.576
May	4.848	5.110	26.923	27.304
June	4.421	5.346	26.750	27.893
July	4.239	5.694	26.262	29.042
August	4.186	6.212	25.068	31.170
September	4.235	6.548	25.256	31.750
October	4.605	6.840	26.315	34.528
November	4.667	7.104	25.949	38.011
December	4.835	6.999	26.900	37.757
Year	4.655	5.716	25.845	30.003

St. Louis quotations, cents per pound. London, pounds sterling, per long ton.

Antimony, Quicksilver and Platinum

	Antimony (a)		Quicksilver (b)		Platinum (c)	
	New York		New York		New York	
	1921	1922	1921	1922	1921	1922
January	5.258	4.463	48.440	49.960	73.400	97.260
February	5.250	4.416	49.545	48.295	70.227	89.545
March	5.282	4.319	46.796	50.204	72.463	87.500
April	5.137	4.980	45.423	52.280	73.404	87.500
May	5.250	5.467	47.000	54.885	73.740	85.529
June	5.087	5.145	46.846	55.115	74.942	87.212
July	4.735	5.091	44.950	55.000	70.440	90.180
August	4.597	5.315	45.028	57.593	73.222	98.370
September	4.564	6.580	42.660	67.640	75.960	117.280
October	5.085	6.905	39.840	72.560	81.800	109.440
November	4.734	6.584	39.804	71.521	82.609	108.000
December	4.500	6.382	49.212	72.300	78.192	113.600
Year	4.957	5.471	45.462	58.946	75.033	97.618

(a) Antimony quotations in cents per lb. for ordinary brands. (b) Quicksilver in dollars per flask. (c) Platinum in dollars per ounce.

Pig Iron, Pittsburgh

	Bessemer		Basic		No. 2 Foundry	
	1921	1922	1921	1922	1921	1922
January	33.96	21.55	31.96	20.15	33.88	21.34
February	28.96	21.46	26.96	19.71	30.25	20.88
March	28.16	21.35	26.46	19.96	27.85	20.83
April	26.96	22.50	24.46	21.26	26.77	22.70
May	26.21	26.36	23.84	26.87	25.56	25.96
June	24.96	26.96	22.66	26.96	24.38	25.96
July	22.84	26.77	20.76	26.33	22.36	25.97
August	21.96	30.44	20.29	27.18	21.53	30.81
September	21.96	35.27	21.21	34.70	22.82	36.79
October	21.96	35.27	20.96	31.77	22.96	33.40
November	21.96	33.52	20.96	29.37	22.74	30.55
December	21.96	29.87	20.65	26.34	21.96	27.69
Year	25.15	27.61	23.43	25.88	5.26	26.91

In dollars per long ton.

Monthly Crude Copper Production

	1922			
	August	September	October	November
Alaska shipments	3,366,952	5,250,340	6,771,700	8,959,037
Washoe Smelter	14,000,000	13,800,000	15,980,000	15,500,000
Calumet & Arizona	4,038,000	3,398,000	3,916,000	3,298,000
Calumet & Hecla	(c)	(c)	(c)	(c)
Other Lake Superior	(c)	(c)	(c)	(c)
Chino	3,443,240	3,390,086	(c)	(c)
East Butte	(c)	(c)	(c)	(c)
Inspiration	(a)	(c)	(c)	(c)
Miami	6,383,000	5,666,715	6,172,000	5,636,000
Nevada Cons.	1,509,353	1,203,894	(c)	(c)
New Cornelia	2,854,183	3,065,400	3,226,618	3,178,556
Old Dominion	2,718,000	2,636,000	2,772,000	2,934,000
Phelps Dodge	7,615,000	7,609,000	6,984,000	9,890,000
Ray	3,844,461	3,532,817	(c)	(c)
Shattuck Arizona	(a)	(a)	(a)	(c)
Southwest Metals Co.	575,000	716,000	(c)	(c)
United Verde	6,000,000	5,310,000	(c)	(c)
United Verde Extension	3,250,934	3,556,010	3,760,234	3,670,206
Utah Copper	10,148,606	10,605,132	(c)	(c)
Others, estimated	10,500,000	10,300,000	11,500,000	11,900,000
Total United States	.....	.....	.....	.....
Imports: Ore and concentrates, matte	11,801,156	12,815,916	.....	.....
Imports of black and blister, unrefined	28,504,557	37,052,679	.....	.....
Imports of refined and old	16,851,411	7,299,193	.....	.....
Grand total	.....	.....	.....	.....
Backus & Johnston	(c)	(c)	(c)	(c)
Boleo	1,364,025	1,160,933	1,214,925	1,128,409
Cananea	(c)	(c)	(c)	(c)
Cerro de Pasco	(c)	(c)	(c)	(c)
Chile	(c)	(c)	(c)	(c)
Cons. M. & S. of Canada	(a)	(a)	(a)	(a)
Falcon Mines	594,000	584,000	584,000	.....
Furukawa	2,771,880	.....	.....	.....
Granby Cons.	2,924,760	2,179,890	2,638,414	3,975,000
Hampden Cloncurry	(c)	(c)	(c)	(c)
Katanga	8,553,195	7,766,010	8,352,540	.....
Mount Morgan	882,000	956,000	.....	.....
Mount Lyell	656,000	2,252,600	(c)	.....
Phelps Dodge Mexican	1,587,000	2,500,000	2,732,000	3,533,000
Sumitomo	4,092,410	2,933,812	2,596,060	.....
Wallaroo & Moonta	(a)	(a)	(a)	(a)

Comparative Annual Copper Production

	1919	1920	1921	1922
January	135,733,511	121,903,744	90,596,597	32,010,292
February	111,649,512	117,540,000	86,682,941	45,957,530
March	102,040,460	120,309,316	91 046,345	55,705,760
April	98,808,998	116,078,871	46,946,523 (b)	76,601,000
May	92,652 975	114,964,207	25,310,511 (b)	88,714,000
June	95,856,570	116,107,856	24,623,693 (b)	93,740,000
July	100,369,247	109,729,610	22,033,739 (b)	91,000,000
August	107,994,040	112,460,254	23,248,398 (b)	101,188,000
September	108,703,075	104,919,562	23,855,316 (b)	96,408,000
October	115,143,143	105,231,571	23,231,572 (b)	103,273,000
November	117,289,735	106,700,178	28,341,442	.....
December	102,997,633	95,709,009	29,629,137	.....

(a) No copper produced during this month. (b) Department of Commerce. (c) Not available.

MINING STOCKS

Week Ended Dec. 30, 1922

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Ahmeek	Boston	58	57	57	Dec. '22, Q	$1.00
Alaska-Br. Col.	N. Y. Curb	1⅞	1¾	1⅞		
Allouez	Boston	24	22½	22½	Mar. '19	1.00
Anaconda	New York	50½	48	50½	Nov. '20, Q	1.00
Arcadian Consol.	Boston	4¼	3½	3¾		
Ariz. Com'l.	Boston	7⅛	7	7⅛	Oct. '18, Q	0.50
Bingham Mines	Boston	†18¼	†17½	18	Sept. '19, Q	0.25
Calumet & Arizona	Boston	58	56	56	Dec. '22, Q	0.50
Calumet & Hecla	Boston	289	283	289	Dec. '22, Q	5.00
Canada Copper	N. Y. Curb	*3	*2	*3		
Centennial	Boston	8⅛	8⅛	8⅛	Dec. '18, SA	1.00
Cerro de Pasco	New York	45½	43¼	45½	Mar. '21, Q	0.50
Chile Copper	New York	27⅛	26⅝	27⅛		
Chino	New York	27½	25½	26½	Sept. '20, Q	0.37
Copper Range	Boston	38	35⅝	36½	Mar. '22, Q	1.00
Crystal Copper	Boston Curb	1½	1⅛	1 1/16		
Davis-Daly	Boston	3	2½	3	Mar. '20, Q	0.25
East Butte	Boston	9	8⅛	9	Dec. '19, A	0.50
First National	Boston Curb	*42	*33	*35	Feb. '19, SA	0.15
Franklin	Boston	1⅛	1⅛	1⅛		
Gadsden Copper	N. Y. Curb	*80	*80	*80		
Granby Consol.	New York	26¼	23	24⅛	May '19, Q	1.25
Greene-Cananea	New York	28	27	27⅛	Nov. '20, Q	0.50
Hancock	Boston	2⅛	2⅛	2⅛		
Howe Sound	N. Y. Curb	2¼	2⅛	2⅛	Jan. '21, Q	0.05
Inspiration Consol.	New York	36¼	33¼	35⅜	Oct. '20, Q	1.00
Iron Cap	Boston Curb	5	4¼	4½	Sept. '20, K	0.25
Isle Royale	Boston	22⅛	21⅛	21⅛	Dec. '22, K,	0.50
Kennecott	New York	37	35⅛	36⅛	Dec. '20, Q	0.50
Keweenaw	Boston	1⅛	1	1⅛		
Lake Copper	Boston	3⅛	3	3		
Magma Copper	New York	32½	30	31½	Jan. '19, Q	0.50
Mason Valley	N. Y. Curb	1¼	1⅛	1⅛		
Mass Consolidated	Boston	2	1½	1⅝	Nov. '17, Q	1.00
Miami Copper	New York	27½	27	27½	Nov. '22, Q	0.50
Michigan	Boston	2½	1⅞	2⅛		
Mohawk	Boston	58½	55	58	Nov. '22, Q	1.00
Mother Lode Coa.	New York	11¼	10⅜	11¼	Dec. '22, K	0.50
Nevada Consol.	New York	16¼	15½	15½	Sept. '20, Q	0.25
New Cornelia	Boston	18	17⅛	17⅛	Nov. '22, Q	0.25
North Butte	Boston	9⅛	8⅝	9⅛	Oct. '18, Q	0.25
Ohio Copper	N. Y. Curb	*58	*49	*56		
Old Dominion	Boston	19	17⅛	17⅛	Dec. '18, Q	1.00
Osceola	Boston	33	31½	32½	Dec. '22, K.	1.00
Phelps Dodge	Open Mar.	†165	†160	...	Oct. '22, Q	1.00
Quincy	Boston	37	34	35	Mar. '20, Q	1.00
Ray Consolidated	New York	14⅞	14⅛	14⅛	Dec. '20, Q	0.25
Ray Hercules	N. Y. Curb	1¼	1⅛	1⅛		
St. Mary's Min. Ld.	Boston	41	41	41	Apr. '22, K	2.00
Seneca Copper	Boston	8	7⅛	7⅛		
Shannon	Boston	*65	*53	*53	Nov. '17, Q	0.25
Shattuck Arizona	New York	8⅛	8⅛	8⅛	Jan. '20, Q	0.25
South Lake	Boston	*30	*30	*30		
Superior & Boston	Boston	2½	2 1/16	2⅛		
Tenn. C. & C. cfs.	New York	10⅞	10⅛	10⅛	May '18, I	1.00
Tuolumne	Boston	*52	*52	*52	May '13,	0.10
United Verde Ex.	N. Y. Curb	27⅛	27	27⅛	Nov. '22, Q	0.25
Utah Consol.	Boston	1⅛	1⅛	1⅛	Sept '18,	0.25
Utah Copper	New York	65⅛	63⅛	65	Dec. '22, Q	0.50
Utah Metal & T.	Boston	*99	*90	*95	Dec. '17,	0.30
Victoria	Boston	1	1	1		
Winona	Boston	1⅛	1⅛	1⅛		
Wolverine	Boston	8	7½	8		
NICKEL-COPPER						
Internat. Nickel	New York	13⅜	13⅛	13⅛	Mar. '19,	0.50
Internat. Nickel, pfd.	New York	68⅛	65	68¼	Nov. '22, Q	1.50
LEAD						
Carnegie Lead & Zinc	Pittsburgh	4½	4½	4½		
National Lead	New York	128	125	128	Dec. '22, Q	2.00
National Lead, pfd.	New York	†114	†112	112½	Dec. '22, Q,	1.75
St. Joseph Lead	New York	19	18½	19	Dec. '22, Q,X	0.50
ZINC						
Am. Z. L. & S.	New York	16	15⅛	16	May '20,	1.00
Am. Z. L. & S. pfd.	New York	48	48	48	Nov. '20, Q	1.50
Butte C. & Z.	New York	10	9	10	June '18,	0.50
Butte & Superior	New York	32¼	31½	31½	Dec. '22,	0.50
Callahan Zn-Ld	New York	10	9½	10	Dec. '20, Q	0.50
New Jersey Zn.	N. Y. Curb	175	172	172	Nov. '22, Q	2.00
Yellow Pine	Los Angeles	*75	*75	*75	Sept. '20, Q	0.03
SILVER						
Batopilas Mining	New York	⅛	⅛	⅛	Dec. '07, I	0.12½
Beaver Consol.	Toronto	*30	*28½	*30	May '20, K	0.03
Candelaria	N. Y. Curb	*30	*28	*29		
Coniagas	Toronto	1.90	1.90	1.90	May '21, Q	0.12½
Crown Reserve	Toronto	*31¼	*30½	*31½	Jan. '17,	0.05
Kerr-Lake	N. Y. Curb	3¼	3⅛	3⅛	Oct. '22, Q	0.12½
La Rose	Toronto	*23½	*23½	*23½	Apr. '22,	0.10
McKinley-Dar.-Sav.	Toronto	...	...	*21	Oct. '20, Q	0.03
Mining Corp. Can.	Toronto	*97	*97	*97	Sept. '20, Q	0.12½
Nipissing	N. Y. Curb	6	5¼	5¼	Oct. '22, Q,X	0.30
Ontario Silver	New York	5¼	5⅛	5⅛	Jan. '19, Q	0.50
Temiskaming	Toronto	*32	*31	*32	Jan. '20, K	0.04
Trethewey	Toronto	3½	3½	3½	Jan. '19,	0.05

Stock	Exch.	High	Low	Last		Last Div.
GOLD						
Alaska Gold	New York	⅛	⅛	⅛		
Alaska Juneau	New York	1⅛	1	1⅛		
Atlas	Toronto	*15	*14½	*15		
Carson Hill	Boston	7⅛	6⅞	6⅞		
Cresson Consol. G.	N. Y. Curb	2 1/16	2⅛	2 1/16	Oct. '22 Q.	0.10
Dome Mines	New York	44½	42	42½	Oct. '22, Q	0.50
Golden Cycle	Colo. Springs	*88	*88	*88	June '21, Q	0.02
Hollinger Consol.	Toronto	12.20	12.10	12.20	Dec. '22,	0.05
Homestake Mining	New York	80	80	80	Dec. '22, M	0.50
Keora	Toronto	*9½	*9½	*9½		
Kirkland Lake	Toronto	*40	*39	*39		
Lake Shore	Toronto	2.86	2.84	2.85	Nov. '22, Q	0.02
McIntyre- Porcupine	Toronto	18.00	17.90	17.90	Sept. '22, K	0.25
Porcupine Crown	Toronto	*17	*16	*16	July '17,	0.03
Portland	Colo. Springs	†*40	†*37	*38	Oct. '20, Q	0.01
Schumacher	Toronto	*45	*43	*43		
Teck Hughes	Toronto	*85	*85½	83½		
Tom Reed	Los Angeles	*75	*72½	*73	Dec. '19,	0.02
United Eastern	N. Y. Curb	2 1/16	1 1/16	2 1/16	Oct. '22, Q	0.15
Vipond Cons.	Toronto	*70	*67½	*70		
White Caps Mining	N. Y. Curb	*11	*10	*10		
Wright-Hargreaves	Toronto	3.10	3.10	3.10	Oct. '22,	0.05
Yukon Gold	N. Y. Curb	*80	*73	*75	June '18,	0.02½
GOLD AND SILVER						
Boston-Mont. Corp.	N. Y. Curb	*17	*11	*17		
Cons. Virginia	San Francisco	*11½	*10½	*10½		
Continental Mines	N. Y. Curb	5¼	4⅛	4⅛		
Dolores Esperanza	N. Y. Curb	2	1⅝	1⅞	Oct. '22	2.50
Tonopah Belmont	N. Y. Curb	1⅛	1⅛	1⅛	July '22, Q	0.05
Tonopah Divide	N. Y. Curb	*72	*61	*72		
Tonopah Extension	N. Y. Curb	3⅛	3⅛	3⅛	Oct. '22, Q	0.05
Tonopah Mining	N. Y. Curb	2 1/16	2	2	Oct. '22, SA, X	0.07½
West End Consol.	N. Y. Curb	1 1/16	1 1/16	1⅛	Dec. '22, Q.	0.05
SILVER-LEAD						
Caledonia Mng.	N. Y. Curb	...	...	*8	Jan. '21, M	0.01
Cardiff M. & M.	Salt Lake	*35	*31	*31	Dec. '20,	0.15
Chief Consol.	Boston Curb	5	4⅛	5	Nov. '22, Q	0.10
Columbus Rexall	Salt Lake	*22	*21	*22	Aug. '22,	0.03
Consol. M. & S.	Montreal	...	...	24¾	Oct. '20, Q	0.62½
Eagle & Blue Bell	Boston Curb	†3	†2	3	Nov. '22, K	0.05
Federal M. & S.	New York	10	9	9½	Jan. '09,	1.50
Federal M. & S. pfd.	New York	51	43½	46½	Dec. '22, Q	1.25
Florence Silver	Spokane	*37	*36	*36	Apr. '19,	0.01½
Hecla Mining	N. Y. Curb	8⅛	7⅛	8⅛	Dec. '22, Q,X	0.50
Iron Blossom Con.	N. Y. Curb	*35	*30	*35	Apr. '22, Q	0.02½
Marsh Mines	N. Y. Curb	*6	*6	*6	June '21, I	0.02
Park City	Salt Lake	3.35	3.35	3.35		
Prince Consol.	Salt Lake	*9	*8½	*9	Nov. '17,	0.02½
Silversmith	Spokane	*50	*47½	*47½	Oct. '22,	0.01
Simon Silver Lead	N. Y. Curb	*31	*29	*31		
Tamarack-Custer	Spokane	3½	3½	3½	Jan. '21, K	0.04
Tintic Standard	Salt Lake	3.05	2.97½	2.97½	Dec. '22, Q,X	0.10
Utah Apex	Boston	3	2⅞	3	Nov. '20, K	0.25
IRON						
Bethlehem Steel "B"	New York	62½	59⅛	62½	Oct. '22	1.25
Char. Iron	Detroit	...	...	⅛		
Char. Iron, pfd	Detroit	...	...	1⅛		
Colorado Fuel & Iron	New York	27½	24⅛	27½	May '21	0.75
Col. Fuel & Iron, pfd.	New York	...	...	105	Nov. '22	2.00
Gt. North'n Iron Ore	New York	31⅛	29⅛	30⅛	Dec. '22	1.00
Inland Steel	N. Y. Curb	45⅛	45⅛	45⅛	Dec. '22	0.25
Mesabi Iron	N. Y. Curb	12⅛	12⅛	12⅛		
Replogle Steel	New York	24⅛	22	24		
Republic I. & S.	New York	49	45½	48⅛	May '21	1.50
Republic I. S., pfd.	New York	90⅛	83⅛	90⅛	Jan. '22	1.75
Sloss-Sheffield S. & I.	New York	39⅛	39	39⅛	Feb. '21	1.50
U. S. Steel	New York	107⅛	105⅛	106⅛	Dec. '22	1.25
U. S. Steel, pfd.	New York	122	120⅛	121⅛	Nov. '22	1.75
Virginia I. C. & C.	New York	54	54	54	Jan. '22	1.50
Virginia I.C.&C., pfd.	New York	...	...	80	July '22	2.50
VANADIUM						
Vanadium Corp.	New York	35½	31⅛	35	Jan. '21, Q	1.00
ASBESTOS						
Asbestos Corp.	Montreal	66	66	66	Oct. '22, Q	1.50
Asbestos Corp. pfd.	Montreal	86	85	86	Oct. '22, Q	1.75
SULPHUR						
Freeport Texas	New York	20⅛	18⅛	20⅛	Nov. '19, Q	1.00
Texas Gulf	New York	61⅛	59¾	61	Dec. '22, QX	2.00
PLATINUM						
So. Am. Gold & P.	N. Y. Curb	3⅛	2⅛	3		
MINING, SMELTING AND REFINING						
Amer. Metal	New York	53⅛	50⅛	51⅛	Dec. '22, Q	0.75
Amer. Metal pfd.	New York	115⅛	114⅛	114⅛	Dec. '22, Q	1.75
Amer. Sm. & Ref.	New York	56⅛	54	56⅛	Mar. '21, Q	1.00
Amer. Sm.& Ref. pfd	New York	99⅛	97⅛	98⅛	Dec. '22 Q	1.75
Am. Sm. Sec. pfd. A	New York	†102	†100	101⅛	Oct. '22, Q	1.50
U. S. Sm. R. & M.	New York	37⅛	36⅛	37	Jan. '21, Q	0.50
U.S. Sm.R.& M. pfd.	New York	47⅛	47⅛	47⅛	Oct. '22 Q	0.87½

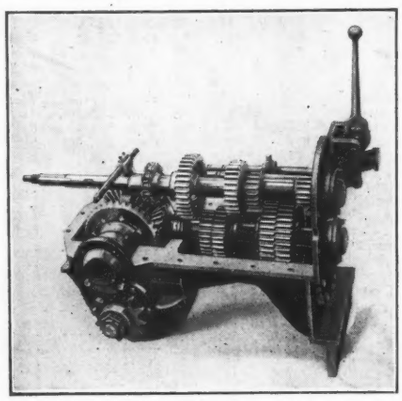
*Cents per share. †Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. K, Irregular. I, Initial. X, Includes extra.

Toronto quotations courtesy Hamilton B. Wills; Spokane, Pohlman Investment Co; Salt Lake, Stock and Mining Exchange; Los Angeles, Chamber of Mines and Oil; Colorado Springs, Colorado Springs Stock Exchange.

NEW MACHINERY AND INVENTIONS

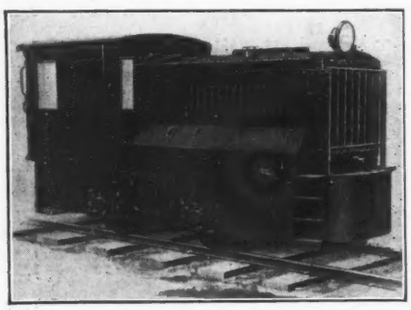
Gear-Drive Gasoline Locomotive Shows High Draw-Bar Pull

A four-speed, seven-ton, gear-drive gasoline locomotive, which claims a draw-bar pull of 5,250 lb., has been developed and recently placed on the market. The four speeds are 2½, 4, 8, and 12 miles per hour, either forward or reverse. The design and construc-



Transmission gears of seven-ton locomotive

tion of the transmission is unusual in that there is an additional final gear drive and shaft. The gears are unusually large, the final drive gear having a 14½-in. diameter and a 4-in. face. This gear is said to permit of the proper speed reduction, and also places the sprocket shaft which drives in the same plane with the axles. The other gears have 2- and 2½-in. faces, respectively.



Four-speed, seven-ton gasoline locomotive

Sliding gears are made in pairs on the second driving shaft, and the gears that are driven are the only ones that are in mesh. Forward and reverse speeds are obtained by large bevel gears, with internal gear teeth, into which the pinion that drives the main gear meshes, thus eliminating the jaw clutches. The final drive is by means of two short heavy chains, one to each axle, driven direct from transmission.

The power plant is a Buda heavy-duty, four-cylinder gasoline engine equipped with magneto, governor, and carburetor. The radiator is a Modine sectional core type, fan-cooled and protected by a heavy steel guard. The axles are mounted on Hyatt roller bearings, with hardened sleeves to take the wear, and the axle springs are 12⅜ in. long, so that the wheels readily follow uneven track.

The frame, built close to the track, is of massive construction. The cab, of all-steel construction, has a side as well as a rear entrance, and these are provided with wired glass windows.

The over-all length of the locomotive is 144 in.; height, 72 in., and the width varies from 51 to 64 in., depending on the gage of track, which ranges from 28⅝ to 56½ in. The Fate-Root-Heath Co., Plymouth, Ohio, are the manufacturers.

INDUSTRIAL NOTES

Edwin L. King has been appointed district sales manager for the Reading Steel Casting Co., Inc., Bridgeport, Conn., with headquarters at 208 South La Salle St., Chicago, Ill., to succeed M. L. Chase, resigned.

The Link-Belt Co. announces the sudden death of Fred A. Marsh, general purchasing agent of the company, on Dec. 11, at the age of fifty-two. Mr. Marsh was a member of the Link-Belt organization for over thirty-three years; was one of the organizers of the Purchasing Agents' Association of Chicago, served ably as the first president; and had been for some years a director in the National Association of Purchasing Agents.

The Wayne Tank & Pump Co., Fort Wayne, Ind., celebrated its thirtieth birthday recently by moving the executive offices into a new office building. The administration building is separate from the main plant buildings and is modern in every respect. Thirty years ago the Wayne company began the manufacture of oil storage tanks and today the company's products consist of oil pumps and storage tanks from the small portable size to great industrial equipment, oil filtration systems, oil-burning equipment, air compressors, and water-softening systems.

Bottiger, Trepp & Cia., La Paz, Bolivia, have ordered a sectionalized 4½-ft. diameter by 16-in. cylinder Hardinge conical ball mill and a 6-ft. by 22-in. sectionalized Hardinge ball mill for the grinding of tin concentrates. The Pittsburgh-Oregon Mining Co., Gold Hill, Ore., has ordered a 4½-ft. by 16-in. Hardinge ball mill to regrind after its stamps for amalgamation and concentration. The Clinchfield Products Corporation, Erwin, Tenn., has ordered two 8-ft. by 48-in. Hardinge pebble mills for the grinding of the company's feldspars to through 140-mesh. The New Mexico School of Mines, Socorro, New Mexico, has ordered a 2-ft. Hardinge ball mill.

TRADE CATALOGS

Turbine Equipment—The power equipment of the Crown Willamette Paper Co.'s mill at West Linn, Ore., is described in a leaflet published by the De Laval Steam Turbine Co., Trenton, N. J. The interest of this installation lies in the fact that the separate sections of the paper machine are driven electrically by direct-current motors, the relative speeds of the several rolls, as required to take up the "draw" or stretch of the paper, being maintained accurately by interconnected synchronous motors belted to the direct-current motor shafts by adjustable cone pulleys. The direct-current generator, driven by a geared turbine which supplies the power, was originally designed to furnish the exhaust steam required by the paper machine. When delivering the amount of steam required by the latter, however, it was found that more direct-current power was produced than was needed, so an alternator has been coupled to the direct-current generator to supply power to the remainder of the mill. The present leaflet describes the variable-speed drive in detail, and should be of interest to engineers having similar problems.

Feed Water Heaters—"Feed Water Heaters in Their Relation to Steam Plant Efficiency" is the title of a 60-p. booklet distributed by the H.S.B.W.-Cochrane Corporation, Philadelphia. The text matter is not primarily descriptive of apparatus, but rather a presentation of the theory and practice of boiler feed water heating. After showing that the most efficient steam cycle is the one in which the feed water is heated from hot well temperature to boiler temperature by the use of steam withdrawn during expansion, various practical forms of apparatus and their uses are taken up, including vacuum deaërating heaters, back-pressure heaters, heaters in conjunction with make-up water evaporators, feed-water heating by stages, different methods of control for securing continuous heat balance, heaters in connection with exhaust steam heating systems, heaters in conjunction with hot water heating and service systems; including heaters operated at temperatures below 212 deg. F., combined heaters and softeners and combined heaters and feed-water meters. The feed-water temperature best for plant efficiency is not a sharply defined quantity, as it is found that the temperature can vary through quite a wide range without seriously affecting overall economy. With the vacuum deaërating type of heater, this becomes entirely practicable; that is, the temperature of the feed water rises and falls according to the relative supplies of condensate and auxiliary exhaust steam or bled steam, without requiring close control by the attendant. The pamphlet should be of timely interest to designers, managers and operators of steam plants.